English

Instructions for Use

HeartStart XL+

Model No. 861290

PHILIPS

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NOTICE

About This Edition

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To determine the product level version to which these Instructions for Use are applicable refer to the version level appearing on the back cover of this book or on the label of the User Documentation CD-ROM that accompanied this device. This information is subject to change without notice.

The information in this document applies to the HeartStart XL+ versions indicated below.

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The HeartStart XL+ complies with the requirements of the Medical Device Directive 93/42/EEC and carries the CE 0123 mark accordingly.

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http://www.philips.com/about/sustainability/reach.page.

Warning

Radio frequency (RF) interference coming from devices other than the HeartStart XL+ may degrade the performance of the device. Electromagnetic compatibility with surrounding devices should be assessed prior to using the defibrillator/monitor.

Use of supplies or accessories other than those recommended by Philips may compromise product performance.

THIS PRODUCT IS NOT INTENDED FOR HOME USE. U.S. FEDERAL LAW RESTRICTS THIS DEVICE TO SALE BY OR ON THE ORDER OF A PHYSICIAN.

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Conventions Used in This Manual

This book contains the following conventions:

WARNING: Warning statements alert you to a potential serious outcome, adverse event or safety hazard. Failure to observe a warning may result in death or serious injury to the user or patient.

CAUTION: Caution statements alert you to where special care is necessary for the safe and effective use of the product. Failure to observe a caution may result in minor or moderate personal injury or damage to the product or other property, loss of data, and possibly in a remote risk of more serious injury and/or cause environmental pollution.

NOTE: Notes contain additional information on usage.

◎ **The "bull's eye" icon indicates a process or a procedure (a set of steps to achieve a certain goal).**

Text represents text that appears on the device screen.

[Soft key text] represents text that appears as a soft key label on the device screen.

"Voice" represent voice prompt messages.

On-line viewing only

Hypertext represents hypertext links, which display as blue; click on the blue link to jump to that destination.

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Introduction

Thank you for choosing the HeartStart XL+ defibrillator/monitor. Whether the HeartStart XL+ is your first Philips product or another in a long list of Philips devices, we welcome you to the Philips family of defibrillators.

The HeartStart XL+ has been developed and designed around you to meet the advanced requirements of hospital code teams, nurses, physicians and biomedical engineers. The device is easy to use in all modes. You can monitor ECG and optional pulse oximetry (SpO_2) and non-invasive blood pressure (NBP). And you can administer therapy using 1-2-3 defibrillation in Manual Mode, 2-step AED Mode, synchronized cardioversion and optional Pacing Mode.

Overview

The HeartStart XL+ is a lightweight, portable defibrillator/monitor. It provides four clinical modes of operation: Monitor, Manual Defibrillation/Synchronized Cardioversion, AED and Pacing.

In Monitor Mode, depending on the ECG cable used, you can view 2 different ECG waveforms at one time on the display. Using a 3-lead ECG cable, you can view either Lead I, II or III. With a 5-Lead ECG cable, you can view two leads from Leads I, II, III, aVR, aVL, aVF or V. Optional monitoring of SpO_2 (numeric and pleth wave) and NBP are available. Measurements and waves are presented on the display and alarms are available to alert you to a change in the patient's condition. You can also display the Vital Signs Trending Report to view all key monitoring parameters and their measurements at a glance.

Manual Defibrillation Mode provides simple 1-2-3 defibrillation. You analyze the patient's ECG and, if appropriate: 1) select an energy setting; 2) charge; and 3) deliver the shock. Defibrillation is performed using paddles (internal or external) or multifunction electrode pads. You can also perform synchronized cardioversion in Manual Defibrillation Mode.

In AED Mode, the HeartStart XL+ analyzes the patient's ECG and determines whether a shock is advised. Voice prompts guide you through the 2-step defibrillation process, while easy-to-follow instruction and patient information (including Adult and Infant/Child patient categories) appear on the display. Voice prompts are reinforced by messages on the display.

Optional Pacing Mode offers non-invasive transcutaneous pacing therapy. Pace pulses are delivered through multifunction electrode pads in Demand or Fixed modes.

The HeartStart XL+ incorporates Philips' low energy SMART Biphasic waveform for defibrillation.

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The HeartStart XL+ automatically stores critical event data such as Event Summaries and Vital Signs Trending. You can also transfer the data to a USB drive and download it to a compatible version of Philips' data management solution – HeartStart Event Review Pro.

The HeartStart XL+ is powered by a rechargeable Lithium Ion battery. Available battery power is determined by viewing the battery power indicators located on the front of the device, the icons on the display, or by checking the gauge on the battery itself. Additionally, AC Power may be applied as a secondary power source and for continual battery charging.

The Ready For Use (RFU) indicator provides a constant status update, indicating the HeartStart XL+ is ready for use, needs attention or is unable to deliver therapy. The device performs automated tests on a regular basis and displays results on the RFU indicator. In addition, performing specified Operational Checks ensures the HeartStart XL+ is functioning properly.

The HeartStart XL+ is highly configurable to better meet the needs of diverse users. Be sure to familiarize yourself with your device's configuration before using the HeartStart XL+. See "Configuration" on page 135 for more details.

Intended Use

The HeartStart XL+ is intended for use in a hospital setting by qualified medical personnel trained in the operation of the device and qualified by training in basic life support, advanced life support or defibrillation.

When operating as a semi-automated external defibrillator in AED Mode, the HeartStart XL+ is suitable for use by medical personnel trained in basic life support that includes the use of an AED.

When operating in Monitor, Manual Defibrillation or Pacing modes, the HeartStart XL+ is suitable for use by healthcare professionals trained in advance life support.

Indications for Use

The HeartStart XL+ is a defibrillator/monitor. The device is for use by qualified medical personnel trained in the operation of the device and certified by training in basic life support, advanced life support or defibrillation. It must be used by or on the order of a physician.

AED Therapy

AED Mode is used in the presence of suspected cardiac arrest on patients that are unresponsive, not breathing and pulseless.

Manual Defibrillation

Asynchronous defibrillation is the initial treatment for ventricular fibrillation and ventricular tachycardia in patients that are pulseless and unresponsive.

Synchronous defibrillation (cardioversion) is indicated for termination of atrial fibrillation.

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Non-Invasive External Pacing

The pacing option is indicated for treating patients with symptomatic bradycardia.

Pulse Oximetry

The SpO_2 option is indicated for use when it is beneficial to assess the patient's oxygen saturation level.

Non-Invasive Blood Pressure Monitoring

The NBP option is indicated for non-invasive measurement of a patient's arterial blood pressure.

ECG Monitoring

ECG monitoring is indicated to be used for monitoring, alarming and recording of the patients' heart rate and morphology.

Safety Considerations

General warnings and cautions that apply to the use of the HeartStart XL+ are provided in "Safety Considerations" on page 40. Additional warnings and cautions specific to a particular feature are provided in the appropriate sections of these instructions.

WARNINGS: The HeartStart XL+ is not intended to be deployed in settings or situations that promote use by untrained personnel. Operation by untrained personnel can result in injury or death.

Electric shock hazards exist internally. Do not attempt to open the device. Refer servicing to qualified personnel.

Use only supplies and accessories approved for use with your HeartStart XL+. Use of non-approved supplies and accessories could affect performance and results.

Use the HeartStart XL+ on one patient at a time.

Use single-use supplies and accessories only once.

NOTE: The HeartStart XL+ has not been tested for use outside a hospital's clinical environment. See "Environmental" on page 204 for use environment specifications.

Getting Started

The HeartStart XL+ comes from the factory ready to use. However, before putting the device into clinical use for the first time, it is recommended you:

- Read these *Instructions for Use* in their entirety.
- Fully charge the battery. See "Power" on page 24.
- Run an Operational Check. See "Operational Check" on page 151.
- Perform a Shift Check. See "Shift Check" on page 147.

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Documentation and Training

Philips Healthcare provides several additional options for HeartStart XL+ documentation and training, besides these *Instructions for Use*, including:

- Quick Reference Card
- Battery Application Note
- ECG Quality Application Note
- Algorithm Application Notes
- Shift Checklist
- User Training DVD
- Service Manual and Training program
- Web-based Training

NOTE: Other application notes can be found on the Philips website at www.philips.com/ProductDocs.

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Device Basics

Introduction

Combining Philips' experience in resuscitation with the current wants and needs of today's medical environment, the HeartStart XL+ has been designed with the clinician in mind.

Philips pioneered 1-2-3 defibrillation for you to defibrillate a patient and save a life quickly and easily. HeartStart XL+ controls, indicators, menus and icons were carefully designed and organized to facilitate ease of use. Display information is designed to present key information for the current task.

This chapter provides a basic orientation on the HeartStart XL+'s external features, including the various color-coded cable ports, installing the battery and printer paper, and optional external paddles.

See "Working with the HeartStart XL+" on page 21 for instructions on how to operate the device.

NOTES: If your HeartStart XL+ does not have some of the optional functionality listed in this chapter, disregard these controls and the related information described throughout this manual.

Pictures of the HeartStart XL+ display appearing throughout this manual are for illustration purposes only. The content of these areas varies with the display view, the options on your device and the function being performed.

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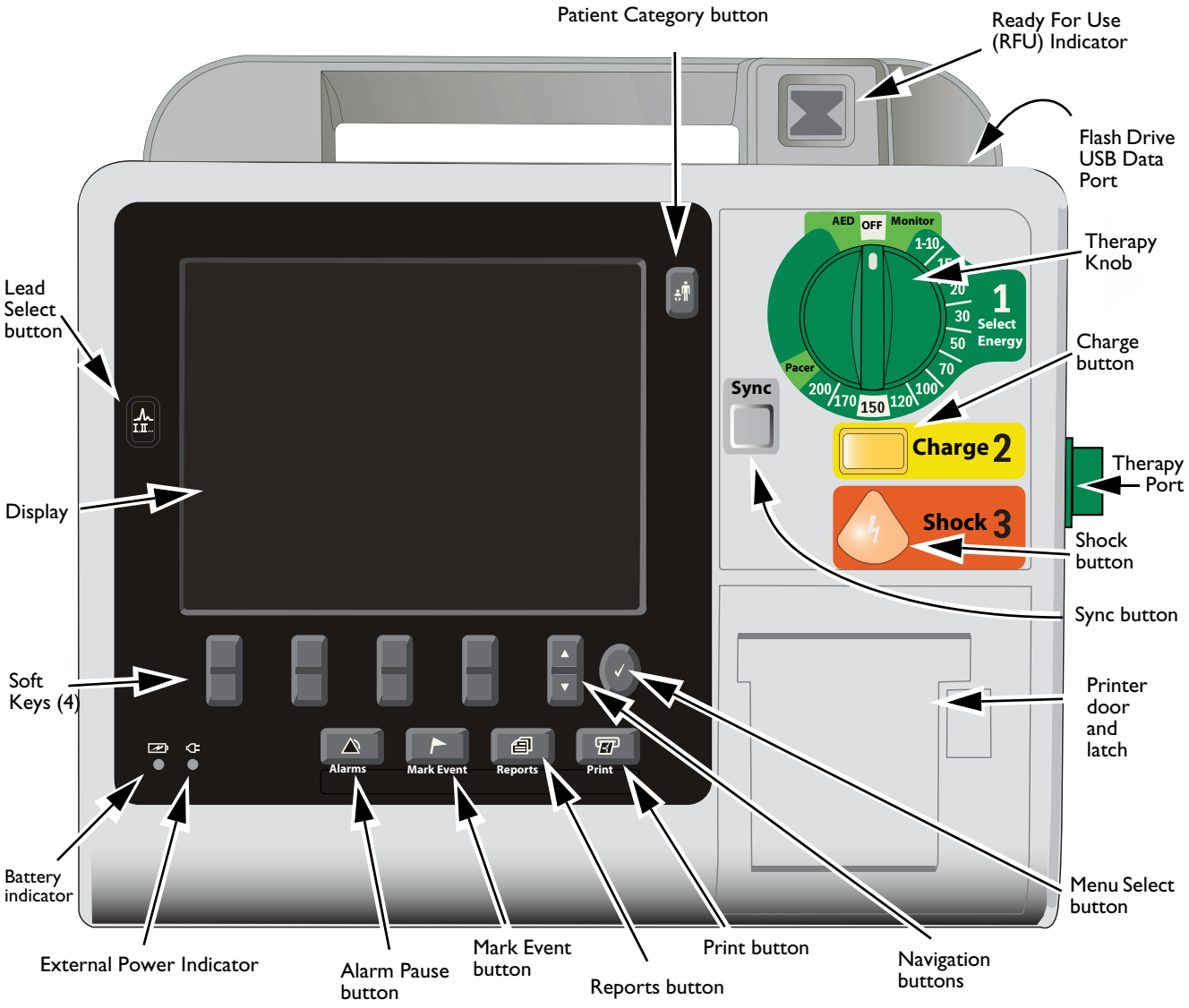
Basic Orientation

This section provides an overview of the HeartStart XL+, options and accessories.

Front of the Device

The front of the device contains operational controls and indicators as shown in Figure 1.

Figure 1 **Front View**

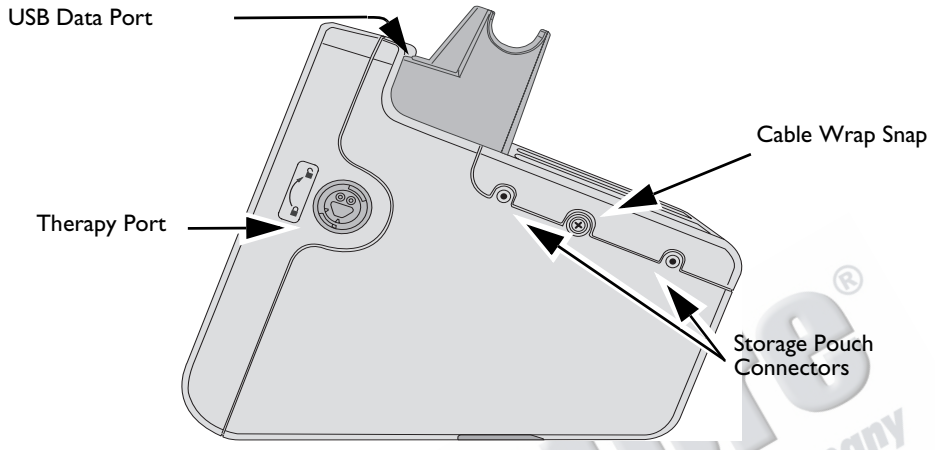


Additional controls and indicators are located on the external paddles (see "External Paddle Features" on page 11) and the Lithium Ion battery (see "Battery Fuel Gauge" on page 14).

Right (Therapy) Side

The right side of the HeartStart XL+ is dedicated to administering therapy. It contains a therapy port for paddles (external or internal) or a therapy cable with multifunction electrode pads.

Figure 2 **Right (Therapy) Side View**

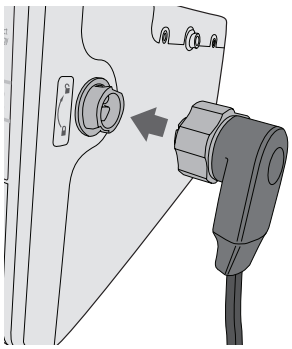


Connecting the Therapy Cable

To connect the Therapy Cable:

1. Align the white pointer on the cable with the white arrow on the green Therapy port, see Figure 3.
2. Insert the cable into the green Therapy port and push until you hear it click into place. Confirm the connection by gently tugging on the cable to make sure it does not come loose.

Figure 3 **Connecting the Therapy Cable**



To detach the Therapy Cable:

1. Rotate the green knob in a clockwise direction as indicated by the lock/unlock symbol next to the Therapy port.
2. Pull the cable away from the device.

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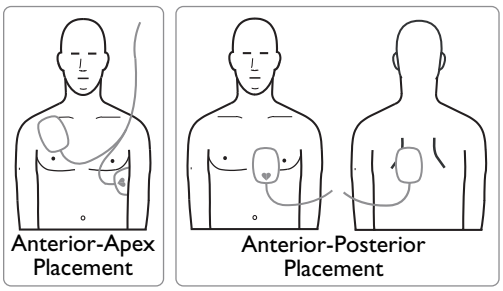
Multifunction Electrode Pads

You can use multifunction electrode pads to monitor and administer therapy to patients with the HeartStart XL+.

Figure 4 **Multifunctional Pads**



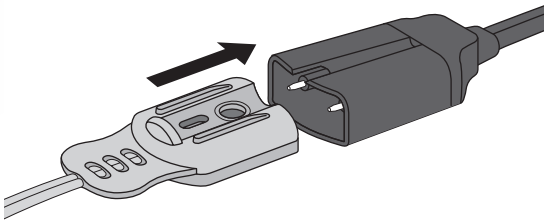
Connecting Multifunction Electrode Pads

To connect multifunction electrode pads:

1. Check the expiration date on the pads package and inspect the package for any damage. Discard expired or damaged pads.
2. Connect the Therapy cable to the HeartStart XL+ (see "Connecting the Therapy Cable" on page 7).
3. Open the package and connect the pads connector to the end of the Therapy cable (see Figure 5).

NOTE: If you are using Philips' HeartStart Preconnect Pads (989803166021), there is no need to open the pads package to connect the pads connector to the Therapy cable.

Figure 5 **Connecting Multifunctional Pads**



4. Apply the pads to the patient as directed on the pads packaging or according to your organization's protocol.

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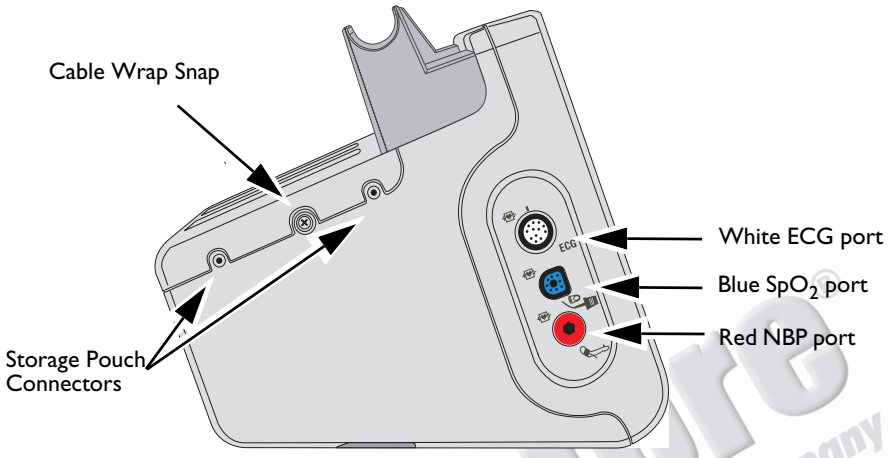
Left (Monitor) Side

The left side of the HeartStart XL+ is dedicated to monitoring key vital signs (see Figure 6). It has ports for ECG, SpO_2 and NBP.

Figure 6 **Left (Monitor) Side View**

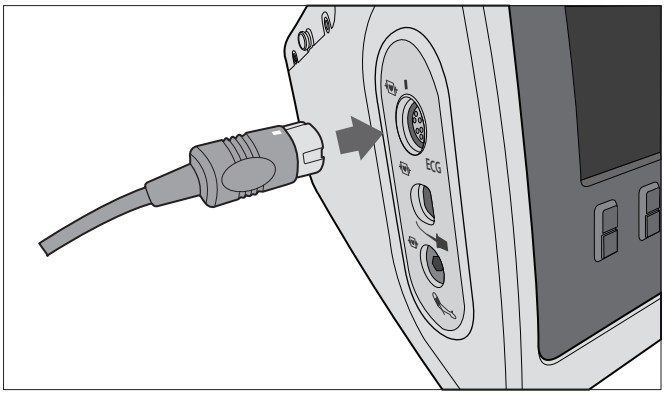


Connecting the ECG cable

To connect a 3- or 5-Lead cable:

1. Align the ECG cable with the white ECG port (see Figure 7). The white key marker on the ECG cable faces the top of the device.
2. Push the ECG cable firmly into the ECG port.

Figure 7 **Connecting the ECG Cable**



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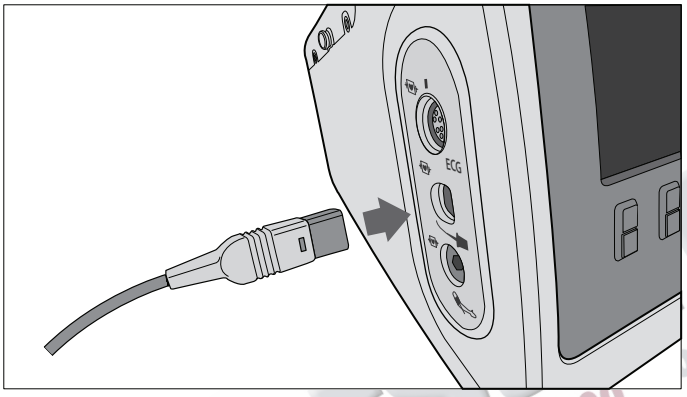
Connecting the SpO_2 Cable

To connect the SpO_2 cable:

1. Hold the cable connector with the flat side and blue marking facing the front of the HeartStart XL+ (see Figure 8).
2. Insert the cable into the blue SpO_2 port and push the blue portion of the connector into the device until it is no longer visible.

Figure 8 **Connecting the SpO_2 Cable**

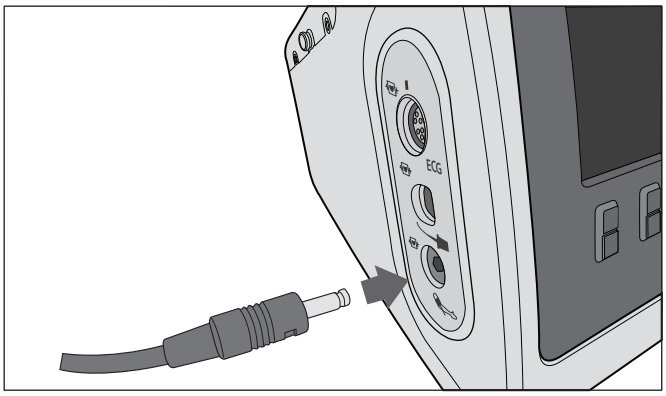


Connecting the NBP Cable

To connect the NBP cable:

1. Insert the NBP cable into the red NBP port (see Figure 9) and push completely in.
2. Attach the NBP cable to the NBP cuff.

Figure 9 **Connecting the NBP Cable**



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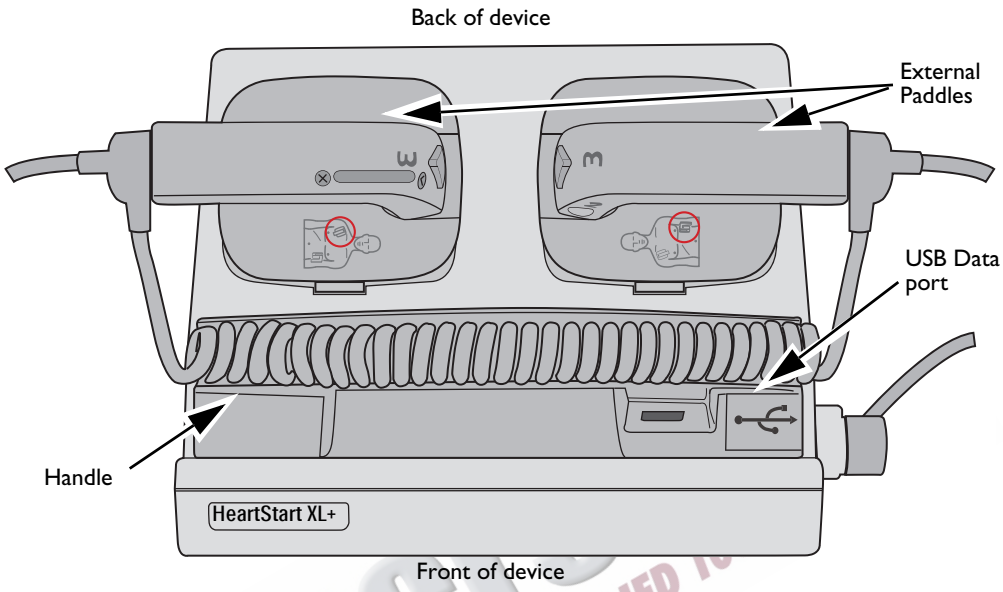
Top Panel

The top of the HeartStart XL+ has a handle for easy transport and also the USB data port. If optional external paddles are present, they reside in the paddle tray on the top of the device as shown in Figure 10.

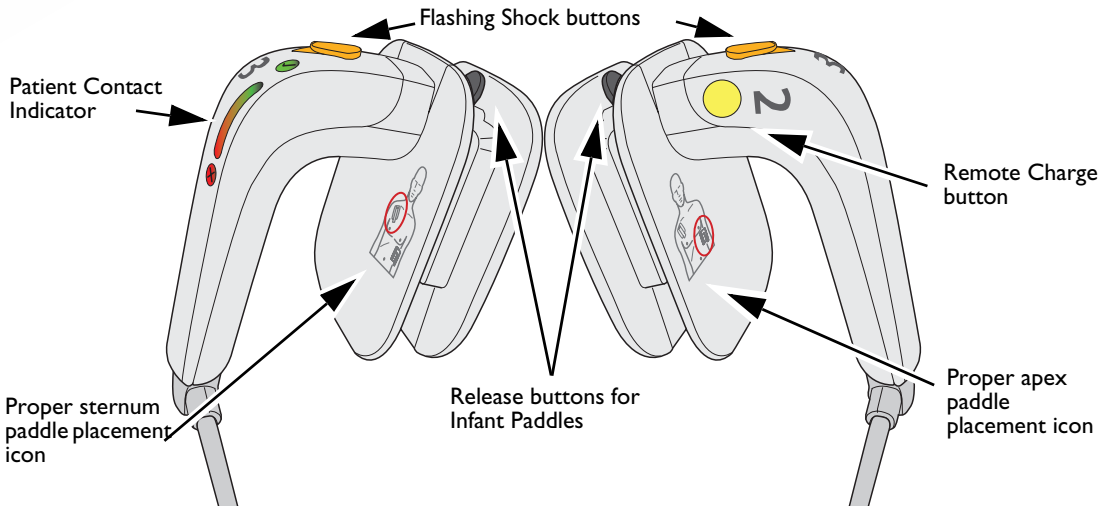
Figure 10 **Top View (with optional paddles installed)**



External Paddles

The M3543A External Paddles can be used on both adult/child (≥ 10kg) and infant (< 10kg) patients. The apex paddle has a yellow button to remotely charge the defibrillator. Both paddles have orange shock buttons that flash when the defibrillator is charged. Press both buttons simultaneously to administer a shock. The sternum paddle contains a Patient Contact Indicator (PCI) with PCI icons. Orange or red lights on the PCI indicate poor patient contact. Adjust paddle pressure and placement to optimize patient contact. Green lights on the PCI indicate good contact is established.

Figure 11 **External Paddle Features**

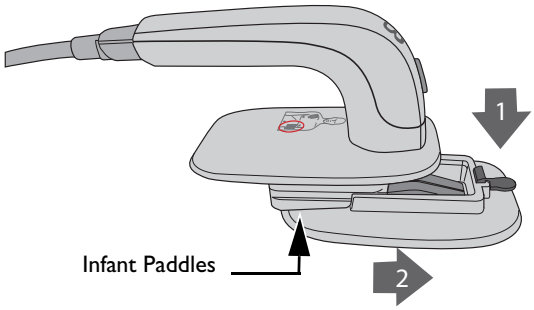

Flashing Shock buttons
Patient Contact Indicator
Remote Charge button
Proper sternum paddle placement icon
Release buttons for Infant Paddles
Proper apex paddle placement icon

Accessing Infant Paddles

To access the M3543A infant paddles:

1. Press down on the release buttons located on the front of the external paddles.
2. Slide the adult electrode clip off and away from the paddle exposing the infant-sized surface underneath.

Figure 12 **Infant Paddles**



WARNING: Make sure the defibrillator is not charged before accessing the infant paddles.

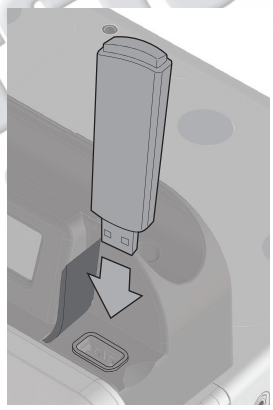
USB Data Port

The HeartStart XL+ allows you to save data to and import configurations and new software revisions from a USB drive which is inserted into a USB port on the top of the device.

To insert a USB drive:

1. Locate the USB data port on the top right of the HeartStart XL+, just to the right of the RFU indicator.
2. Lift the plastic door to expose USB port.
3. Insert your USB drive (USB symbol facing forward) into the port.

Figure 13 **Data Port**



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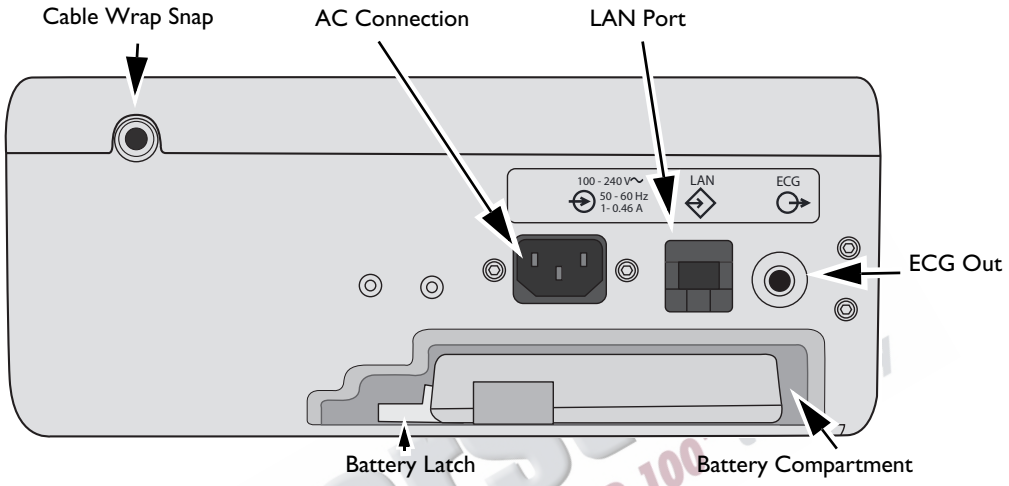
Back Panel

The back panel of the HeartStart XL+ has a compartment for the Lithium Ion battery. It also contains the AC power connection, the ECG Out jack to connect to an external monitor, and the LAN port. See Figure 14. For more information on ECG Out, see the *ECG Out Cable Application Note* which can be found on the Philips website at www.philips.com/ProductDocs.

Figure 14 **Back Side View**



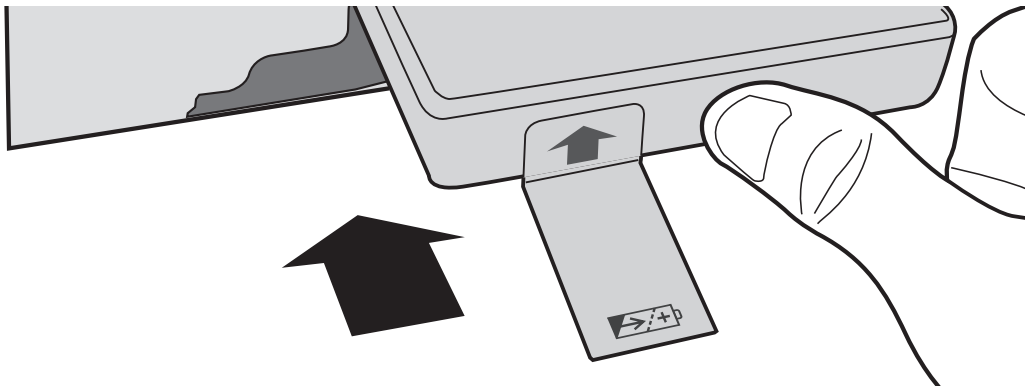
WARNING: Do not connect a LAN cable to the HeartStart XL+ while in a clinical mode. Incorrect ECG diagnosis may result due to excessive noise.

Installing the Battery

To install the HeartStart XL+ Lithium Ion battery:

1. Align the battery in the battery compartment. Confirm the arrow on the Battery Tab is pointed up.
2. Insert the battery into the battery compartment until you hear the Battery Latch lock into place.

Figure 15 **Installing the Battery**



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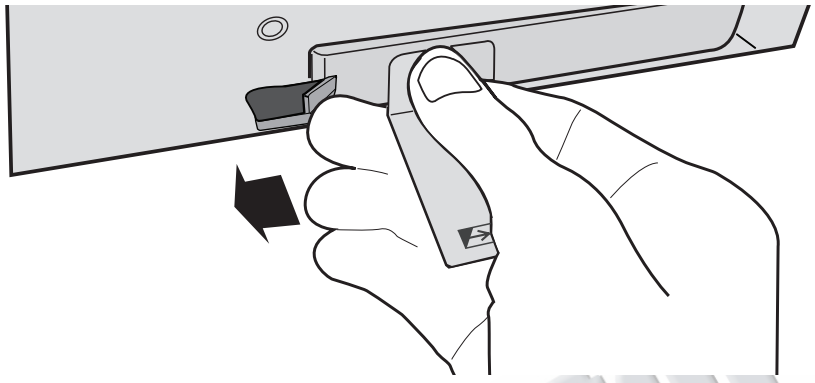
Removing the Battery

To remove the HeartStart XL+ Lithium Ion battery:

1. Push the Battery Latch to the left to eject the battery.
2. Pull on the Battery Tab and battery to completely remove the battery.

Figure 16 **Removing the Battery**



Battery Fuel Gauge

When you want to check the power remaining in your Lithium Ion battery when it is not installed in the HeartStart XL+, press the Battery Power Gauge (see Figure 17) located on the end of the battery opposite the battery tab. Each solid green light indicates approximately 20 percent charge. A flashing green light closest to the button indicates the battery is too weak and must be recharged before use.

Figure 17 **Battery Gauge**

To check the battery power remaining when the battery is inserted in the device, look at the battery gauge on the display (see Figure 29 “Battery Charge Level” on page 28).

WARNING: Use only approved batteries to power the HeartStart XL+. Use of non-approved batteries could affect performance and results.

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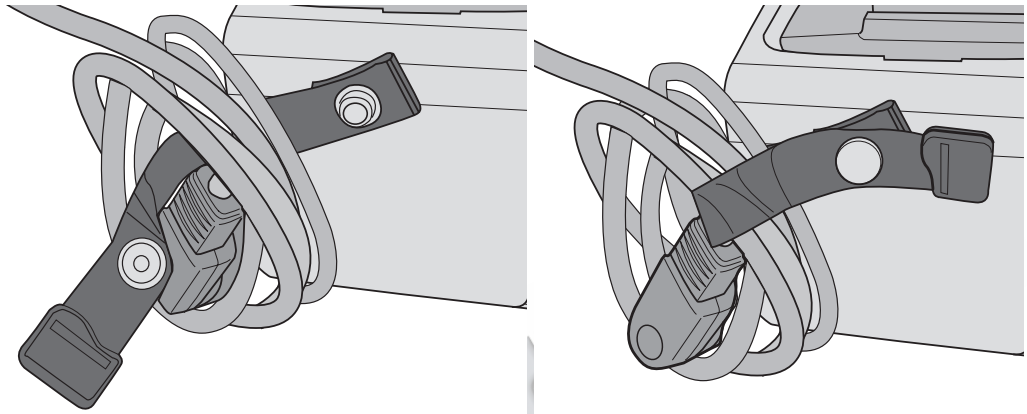
Installing the Cable Wraps

The HeartStart XL+ comes with cable wraps to assist in cable management.

To attach the cable wraps to the HeartStart XL+:

1. Snap the cable wrap into the Cable Management Connector snap on the back of the device.
2. Loop your cable around the cable wrap and snap into place.
3. To remove the cable, tug on the loose end of the cable wrap to unsnap.

Figure 18 **Cable Wrap**



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Accessory Storage System

The HeartStart XL+ can be ordered with an optional Accessory Storage System to assist in cable and accessory management.

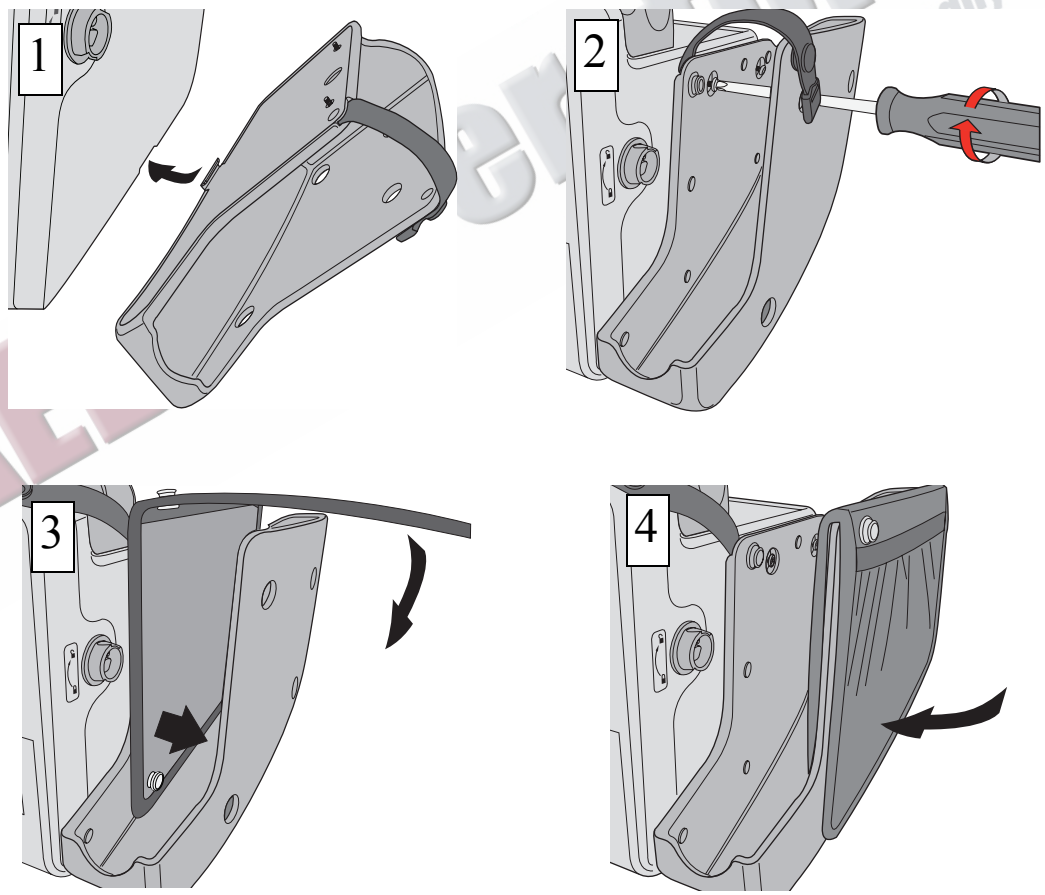
NOTE: You need a Phillips-head screwdriver to install the Accessory Storage System pouches.

Attaching the Pouches

To attach your HeartStart XL+ Accessory Storage System to your defibrillator:

1. Insert the hook on the bottom of the storage system's side pouch into the groove along the side of the HeartStart XL+ (**see Figure 19 - Step 1**).
2. Lift the pouch up into place and secure in two locations with Phillips screws (**see Figure 19 - Step 2**).
3. Drape the double-sided black pocket over the outside end of the pouch, aligning the tapered edge of the bag with the bottom of the pouch. (**see Figure 19 - Step 3**)
4. Secure the bottom edges of the bag by snapping them together through the holes along the bottom edge of the pouch. (**see Figure 19 - Step 4**)

Figure 19 **Attaching the Pouches**



NOTE: Figure 19 illustrates attaching the Accessory Storage System pouch on the right (therapy) side of the device. Use the same procedure to install the pouch on the left (monitoring) side.

Filling the Accessory Pouches

The HeartStart XL+ Accessory Pouches are designed to hold your essential monitoring and defibrillation accessories. Recommended accessory placement includes:

- Monitor side (see Figure 20):
  - Connect the NBP tubing to the NBP port. Coil the remaining tubing with the NBP cuff. Place them in the outside slot of the double-sided black bag.
  - Connect the SpO_2 cable to the SpO_2 port. Coil the remaining cable and finger sensor and place them in the inside slot of the double-sided bag.
  - Connect the ECG cable to the ECG port. Coil the remaining cable and leads and place it in the large pouch.
- Therapy side (see Figure 21):
  - Connect the Therapy cable to the Therapy port. Coil the remaining cable and place it in the large pouch.
  - If you are using pads, place pads in the inside slot of the double-sided bag. If you use paddles, place gel pads or conductive material in the inside slot.

Figure 20 **Monitor Side Accessories**

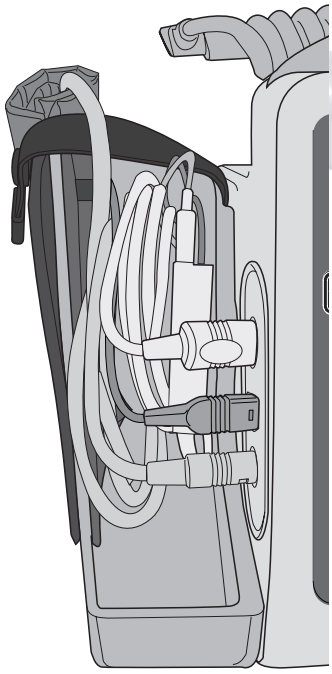
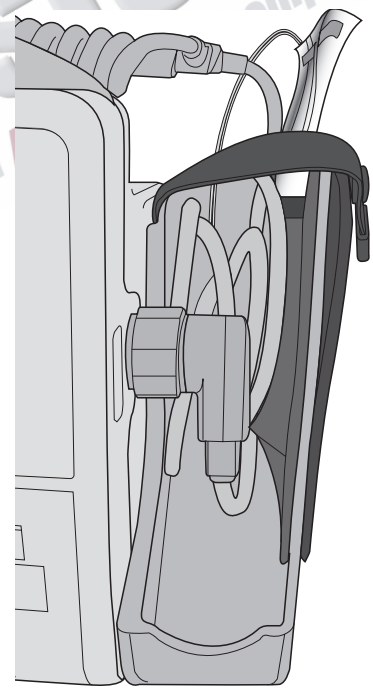


Figure 21 **Therapy Side Accessories**



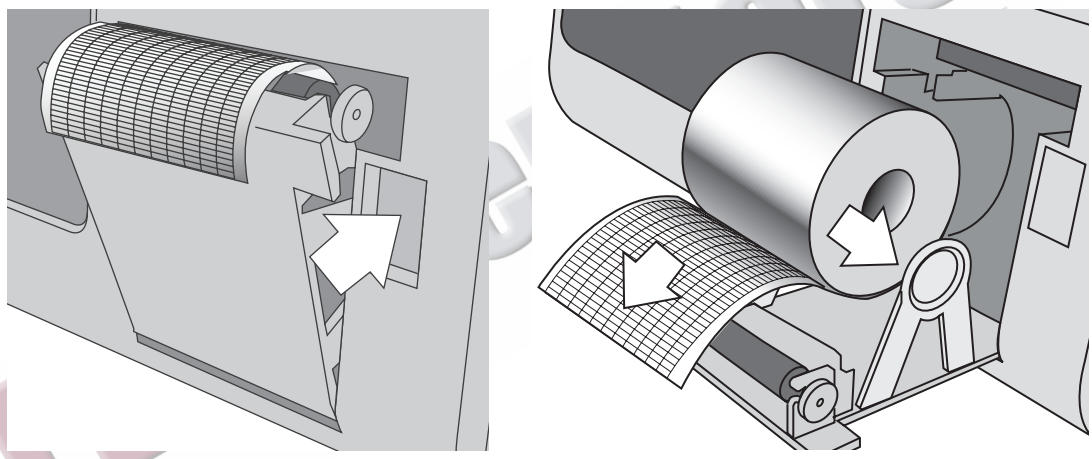
Installing Paper

The HeartStart XL+ uses 50 mm graphed paper for printing.

To install printer paper:

1. Open the printer door by pushing on the printer door latch (see Figure 22).
2. If there is an empty or almost empty paper roll in the printer, pull up on the roll to remove it.
3. Examine the new roll of printer paper and remove any remaining adhesive residue from the outer layer of paper.
4. Place the new roll of paper in the paper well, positioning the roll so that the end of the roll is on the bottom and the grid faces up as indicated by the symbol inside the printer.
5. Pull the end of the paper out past the roller.
6. Close the printer door.
7. Test the printer before putting the defibrillator back into service. See "Printing Data" on page 132.

Figure 22 **Installing Printer Paper**



Test Plug & Test Load

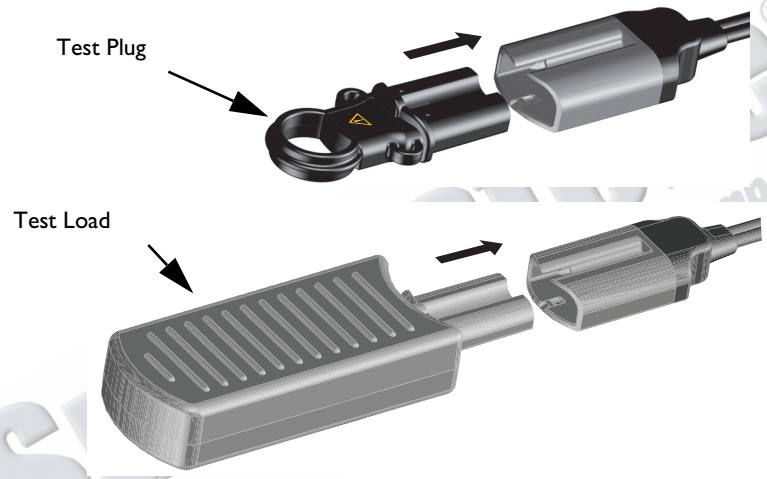
Your HeartStart XL+ comes with a defibrillator Test Plug to assist in performing a Weekly Shock Test. You can also use the M3725A Test Load, ordered seperately, to perform a Weekly Shock Test.

To use either the Test Plug or Test Load during a Weekly Shock Test, insert the plug or load into the Therapy cable (see Figure 23).

The Test Plug and Test Load behave differently during the Weekly Shock Test. The Test Plug creates an electrical "short" while the Test Load applies an impedence at the end of the Therapy cable. Therefore, similar successful Weekly Shock Test results appear differently on the device.

For more on the Weekly Shock Test see "Weekly Shock Test" on page 148.

Figure 23 **Connecting Defibrillator Test Plug/Load**



CAUTION: The defibrillator test plug is not compatible for use with the HeartStart MRx or HeartStart XL.

NOTE: Using the tie provided, tie the test plug about 18 inches (46 cm) from the end of the therapy cable tight enough to prevent the plug from sliding along the cable. The plug should be oriented such that it can easily be inserted into the cable while you have the the cable stowed.

NOTES

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Working with the HeartStart XL+

The HeartStart XL+ was designed and built with clinical use in mind. Philips' designers and engineers, building on our experience as a market leader, worked with clinicians around the globe to confirm the HeartStart XL+ meets clinicians' needs.

Operating Modes

The HeartStart XL+ has four Clinical Modes and four non-clinical modes of operation, each with a customized display (see Table 1).

Table 1 **Operating Modes**

Mode		Description	For more information see
Clinical modes	Monitor	This mode is used to monitor ECG, optional NBP and SpO_2 parameters and for viewing Vital Signs Trending data.	"ECG Monitoring" on page 43
	AED	This mode is used to analyze ECG and if necessary, administer semi-automated external defibrillation. You can also monitor HR and SpO_2.	"AED Mode" on page 59
	Manual Defibrillation	This mode is used to perform asynchronous and synchronous cardioversion (defibrillation).	"Manual Defibrillation" on page 73 and "Cardioversion" on page 81
	Pacer	This optional mode is used to perform demand or fixed pacing.	"Pacing" on page 89
Non-clinical modes	Operational Check	This mode is used to perform routine maintenance activities related to Operational Check.	"Operational and Shift Checks" on page 147
	Data Management	This mode is used to review Event Summaries and other device data after clinical use.	"Data Management" on page 119
	Configuration	This mode is used to display and change the HeartStart XL+'s configuration.	"Configuration" on page 135
	Service	This mode is used when servicing the device, including software upgrades.	The *HeartStart XL+ Service Manual*

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Controls

Operating controls are organized by function with the defibrillation controls to the right of the display, soft keys under the display, general function buttons under the soft keys and to the left and right of the display.

Therapy Knob and Controls

The HeartStart XL+ Therapy knob is customized for the options included in your device. If you have the Pacing Option, a Pacer knob position is included. The knob enables AED Mode, Pacing Mode, Monitor Mode or selects an energy for Manual Defibrillation Mode defibrillation or cardioversion.

Regardless of the options, the knob and controls function the same:

Turning the HeartStart XL+ on – Grasp the Therapy knob and turn to the right for Monitor Mode, Manual Defibrillation or Pacing; turn to the left for AED Mode.

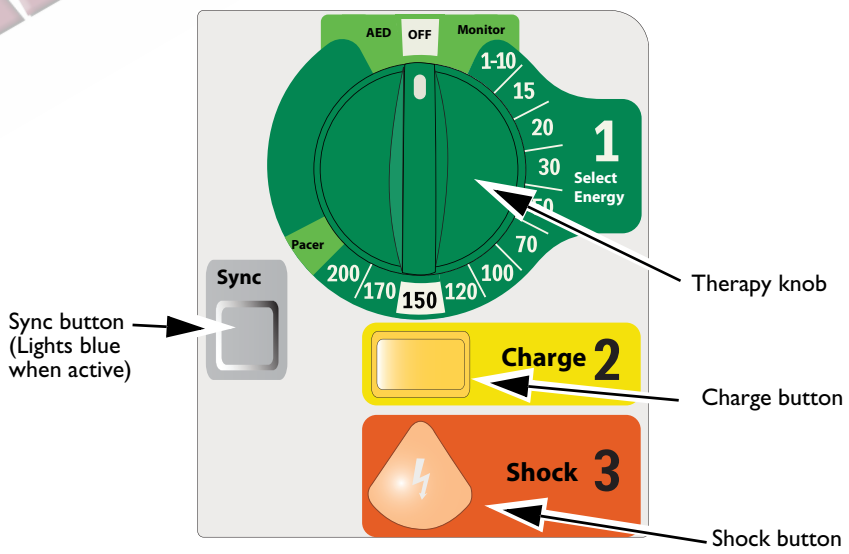
Charge button – Charges the defibrillator to the selected Manual Defibrillation energy setting. It is used only in Manual Defibrillation Mode. The defibrillator charges automatically in AED Mode.

Shock button – Delivers a shock through multifunction electrode pads or switchless internal paddles. In Manual Defibrillation Mode, the shock is delivered at the selected energy. In AED Mode, a 150J shock is delivered if the patient category is set to Adult, 50J if set to Infant/Child. The button flashes when charged.

NOTE: When external paddles or switched internal paddles (internal paddles that have Shock buttons, as opposed to switchless internal paddles where you administer the shock by pressing the Shock button on the device) are used, the HeartStart XL+ delivers a shock by pressing the Shock button(s) located on the paddles.

Sync button – Toggles between synchronized energy delivery used during cardioversion and asynchronous energy delivery used during defibrillation. The Sync button lights blue when Sync is active.

Figure 24 **Therapy Knob and Controls**



General Function Buttons

The General Function buttons control monitoring or non-critical resuscitation activity. See "Basic Orientation" on page 6 for the location of the buttons and below for their definitions.

Lead Select		Changes the ECG lead in Wave Sector 1. Pressing this button cycles through the available ECG waves, changing the displayed wave and label. The list of available ECG waves is based on the connected lead set and your device configuration, including pads, if the corresponding cable is connected. See "Lead Selection" on page 47.
Patient Category		Allows you to quickly change the patient category from adult (≥ 25kg or ≥ 8 years old) to infant/child (<25kg or < 8 years old) and back again.
Menu Select		Pressing the Menu Select button displays the current menu or confirms a menu selection.
Navigation		Pressing either Navigation button displays the current menu. While within a menu or list, pressing the buttons move the selection to the next or previous item on the list. They also increase or decrease numbers or values in a sequence. If you hold either button down, it scrolls.
Alarms		When pressed, the Alarms button pauses all audible physiological and technical alarms for the configured time interval. At the end of the pause interval, each alarm returns to its previous setting. Pressing the Alarms button during the pause interval returns the alarms to their previous setting. When in AED Mode, pressing the Alarms button activates alarms. See "Alarms" on page 33.
Mark Event		The Mark Event button allows you to insert a time-stamped annotation in the Event Summary Report to note events as they occur, including the administration of certain drugs. See "Mark Events" on page 134.
Reports		When pressed, the Reports button will bring up the Reports Menu. From the Reports Menu, you can print an Event Summary or Trends Report. See "Printing Data" on page 132.
Print		The Print button begins a continuous printout of the primary ECG and other selected waveforms either real time or with a 10-second delay, depending upon your configuration. Pressing the Print button while printing is in progress stops the printing. See "Printing Data" on page 132.

Soft Keys

The soft keys perform the function displayed as a label appearing directly above on the display. The display and function change for the various modes of operation. You can hit either the top or bottom of the soft key with the same result - except during pacing therapy. See "Pacing" on page 89 for more information. Functionality of the soft keys are described in their appropriate chapters throughout these *Instructions for Use*. See "Soft Key Labels" on page 30.

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Ready For Use Indicator

The Ready For Use (RFU) Indicator is located on the right side base of the device handle. It indicates the status of the therapy delivery functions using the following conventions:

Blinking Hourglass		Indicates the shock, pacing and ECG functions of the device are ready for use. Sufficient battery power is available for device operation.
Blinking red "X" with periodic audio chirp		Indicates either: • A low battery condition exists and the battery is not charging. • There is no battery installed and the device is running on AC power only.
Blinking red "X" without periodic audio chirp		Indicates a low battery power condition but the battery is currently charging. The device can be used but its battery-only operation time is limited.
Solid red "X" with periodic audio chirp		Indicates a critical failure has been detected that may prevent the delivery of defibrillation therapy, pacing or ECG acquisition.
Solid red "X" without periodic audio chirp		Indicates no power available or the device cannot power on. If, after power is returned, the indicator reverts to the blinking black hourglass symbol, the device is ready for use.

Power

The HeartStart XL+ is powered by a Lithium Ion battery or AC power. The battery should always be installed so the device is ready for use whether or not AC power is available at the point of care. When pacing, AC power should be connected if possible to prevent the battery from eventually becoming depleted and interrupting the pacing operation.

Keep your battery charged at all times. For more information on your battery see "The Display" on page 27, and "Battery Maintenance" on page 166.

NOTES: If AC power is used as the only power source during defibrillation (for instance when no battery is installed or when the battery is fully discharged), the HeartStart XL+ may take longer to charge to the desired energy level, and, in the event of power loss, all settings reset to configured settings and a new event is created when power is returned. However, all saved data remains intact (up to the device's memory capacity) and can be found by retrieving the previous event. Keep your battery installed and charged.

To ensure proper grounding reliability, the HeartStart XL+ must be plugged into a hospital-grade outlet. To remove AC power, disconnect the power cord from the outlet.

If you question the AC power cord's functionality, disconnect it from the device and operate on battery power. Replace the cord before reconnecting to AC power.

For information on power-related alarms see "Power-Related Alarms" on page 169.

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Lithium Ion Battery

The HeartStart XL+ uses a Lithium Ion battery for power.

Battery Life

Battery life depends on the frequency and duration of use. When properly cared for and used in its intended environment, the HeartStart XL+ Lithium Ion battery has a useful life of approximately 3 years. Use outside those conditions could significantly reduce battery life. To optimize performance, a battery that is in the low battery condition (less than 40% remaining) should be charged as soon as possible.

Battery Capacity

A new fully-charged battery, at 20 °C (68 °F), provides power for at least:

- 175 full-energy charge/shock cycles.

  or

- Three hours of monitoring (ECG and SpO_2 continuously monitored and NBP sampled every 15 minutes) followed by 20 full-energy charge/shock cycles.

  or

- Two hours of pacing (180ppm at 140mA with 40msec pulse) and monitoring followed by 20 full-energy charge/shock cycles.

Low Battery Conditions

The HeartStart XL+ enters a low battery condition when:

- The battery charge is low but contains sufficient power to provide at least six full-energy charge/shock cycles and at least 10 minutes of monitoring.
- The HeartStart XL+ cannot determine the battery's charge level.

NOTE: The longer the battery stays in the Low Battery condition without charging, the ability to deliver six full-energy shocks and perform 10 minutes of monitoring diminishes.

Battery Maintenance

For information on battery maintenance, see "Battery Maintenance" on page 166.

Power Indicators

The Power Indicators are located in the lower left corner of the HeartStart XL+'s front panel (see Figure 25.)

The green AC Power Indicator is lit whenever AC power is connected to the HeartStart XL+, even if the device is turned off.

The green Battery Charging Indicator flashes when the battery is charging. The indicator is solid green when the battery is fully charged and AC power is present. The light is off if no battery is installed, the battery is installed but not functioning properly or there is no AC power present.

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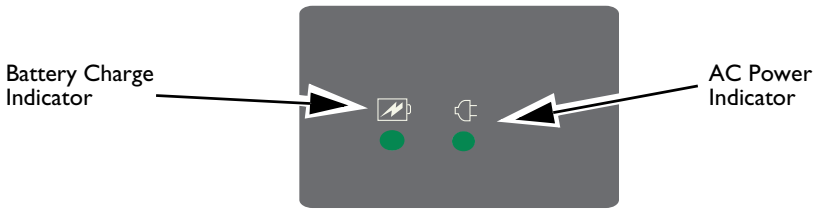
Figure 25 **Power Indicators**



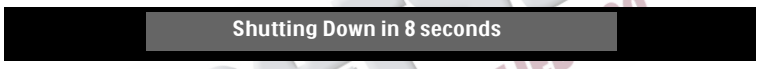
Turning the HeartStart XL+ On

To turn the HeartStart XL+ on, turn the Therapy knob to the desired mode of operation.

Turning the HeartStart XL+ Off

To turn the HeartStart XL+ off, turn the Therapy knob to the **Off** position. If you turn the device off while in a clinical mode, the HeartStart XL+ enters the Continued Use Period (see "Continued Use" on page 39). The screen displays a 10-second countdown (see Figure 26) before turning off.

Figure 26 **Shut Down Countdown**



NOTE: You should leave the device plugged in to keep the battery charged and allow automated diagnostic tests to run periodically.

Device Shutdown

When no AC power is connected and the battery charge level drops to a critically low level, the HeartStart XL+ can no longer guarantee correct operation. The defibrillator generates an Imminent Shutdown alarm. You have approximately one minute to connect the device to AC power before it shuts down.

If power is returned within 30 seconds and the Therapy knob is not in the **Off** position, the HeartStart XL+ automatically turns back on, user settings are restored to their values prior to the shutdown, the HeartStart XL+ continues to use the current Event Summary and the duration of the shutdown is recorded in the Event Summary.

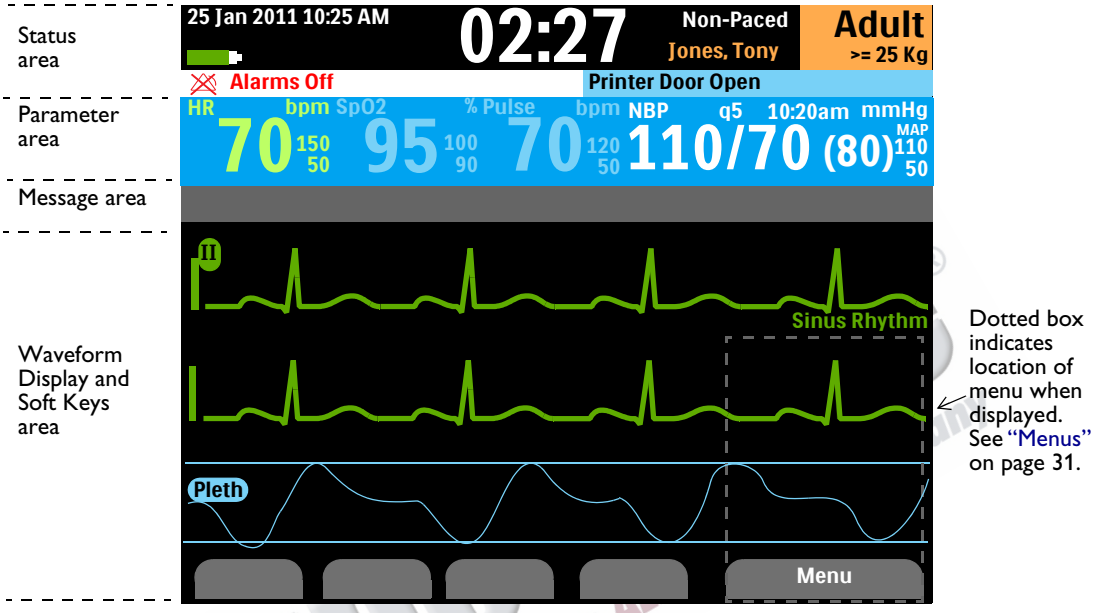
WARNING: Pacing is not automatically restarted after the HeartStart XL+ recovers from a power loss. You must restart pacing manually.

If the HeartStart XL+ restarts after 30 seconds and the Therapy knob is not in the **Off** position, all settings are returned to their configured values, a new Event Summary starts and you are notified that the previous Event Summary was closed.

The Display

The HeartStart XL+'s display layout is easily configurable. There are four basic segments of the display. See Figure 27.

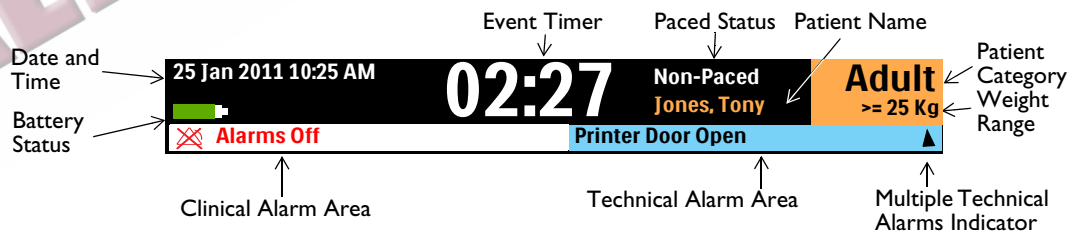
Figure 27 **General Display Layout**



Status Area

The Status Area contains key device and patient information, see Figure 28.

Figure 28 **Status Area**



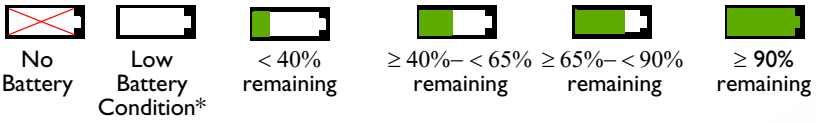
Patient information includes:

- Name – The patient's name for the current event (if entered).
- Date and Time – The current date and time
- Paced Status – Internally paced or non-paced. The area remains blank if paced status has not been selected. (This information is not displayed in Pacing Mode.)
- Event Timer – The elapsed time for the current event, displayed in hours:minutes:seconds
- Patient Category and Weight Range – Adult (defined as ≥ 25kg) or Infant/Child (defined as < 25kg). (The neonatal patient category is not supported for AED Mode and all monitoring functions.)

Device information includes:

- Clinical Alarm Indicator - Indicates the state of global alarms. If alarms are on, the indicator is blank. If they are off, the indicator says **Alarms Off** and uses the Alarms Off icon .
- Technical Alarms - Technical alarms not related to the battery or pacing are displayed in the Technical Alarms area. A triangle ▲ indicates there are multiple alarms present, alternating on the display.
- Battery Status – If a battery is installed, the battery icon indicates the level of charge remaining. See Figure 29.

Figure 29 **Battery Charge Level**



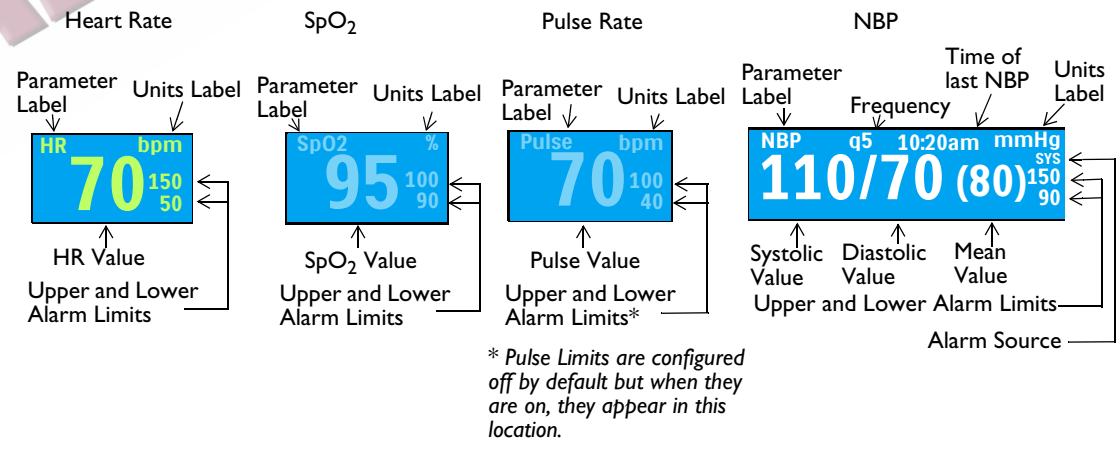
* - See "Low Battery Conditions" on page 25.

Parameter Area

The Parameter Area displays the key physiological parameters currently being monitored, see Figure 30. Displayed values for each parameter include:

- Parameter Label
- Current value. Display:
  - Number – a valid value was obtained
  - **- ? -** – an invalid value was obtained
  - **?** with a number – the value obtained is questionable
  - blank – the parameter is unavailable or off
- Currently configured upper and lower alarm limits with the units label

Figure 30 **Parameter Area**



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Message Area

The message area displays key messages during an event. The type of message shown varies according to the current mode.

Figure 31 **Message Area**

Waveform and Display Soft Keys Area

The HeartStart XL+ is configured to populate each of its three wave sectors with a preconfigured waveform when powered on in Monitor, Manual Defibrillation, Pacing Mode (two wave sectors only) and AED (one wave sector). A dashed line in an ECG wave sector indicates that the waveform source is invalid. Wave sectors may contain a variety of information as appropriate to the parameter, view and task currently being performed.

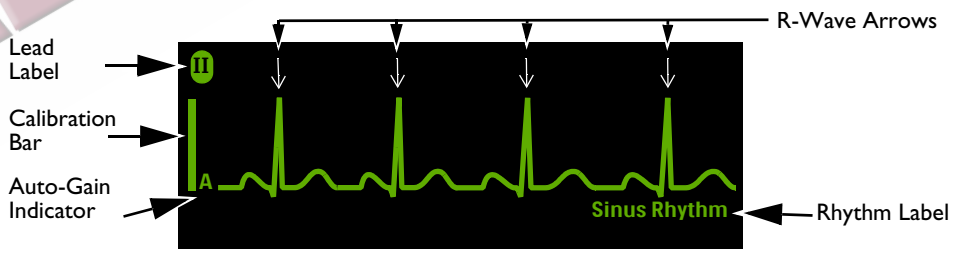
You can display one, two or three waveforms at one time on the display depending on which mode the HeartStart XL+ is currently in and how you have your device configured. The area also displays other key information including the number of shocks delivered and the selected energy.

Wave Sector 1

Wave Sector 1 contains only an ECG waveform. This waveform is used by the arrhythmia, heart rate derivation and AED analysis algorithms. Available waveforms include: Paddles (unavailable in AED Mode), Pads, I, II, III, aVR, aVL, aVF and V.

Wave Sector 1 also contains the ECG Calibration Bar, the Auto-Gain Indicator, Rhythm Label and R-Wave arrows. The Calibration Bar is used as a reference point to compare the actual ECG wave displayed to the selected size. The Auto-Gain Indicator is displayed when auto-scaling is active. R-Wave arrows appear when the device is in Sync Mode, Monitor Mode or Demand Mode Pacing.

Figure 32 **Wave Sector 1 Markings**



After the ECG analysis algorithm analyzes the waveform in Wave Sector 1, it labels the rhythm. Possible labels include:

- Learning ECG
- Learning Rhythm
- Asystole
- V-Fib/Tach
- V-Tach
- Paced Rhythm
- Sinus Brady
- Sinus Rhythm
- Sinus Tachy
- SV Brady
- SV Rhythm
- SV Tachy
- Unknown ECG Rhythm
- Cannot Analyze ECG

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NOTES: In synchronized cardioversion mode, the R-Wave arrows indicate which R-Waves would trigger a shock if the shock button is pressed.

In Demand Mode Pacing, the time until the next delivered external pace pulse is from the previous pace pulse or the R-Wave arrow, whichever is the most recent. R-Waves immediately after the an external pace pulse are not marked because they are likely caused by the pace pulse.

The displayed heart rate is determined by the arrhythmia analysis which is independent from R-Wave arrows for synchronized cardioversion or for Demand Mode pacing.

Wave Sectors 2 & 3

Wave Sectors 2 and 3 are automatically populated when the parameter source's cable is connected to the HeartStart XL+. If the parameter source is the configured choice of a particular wave sector, it is displayed in that wave sector when available. Available waveforms include: Paddles, Pads, I, II, III, aVR, aVL, aVF, V, Pleth and a Cascade Wave from Wave Sector 1.

You can also select an annotated ECG for Wave Sector 2. See "Displaying an Annotated ECG" on page 51.

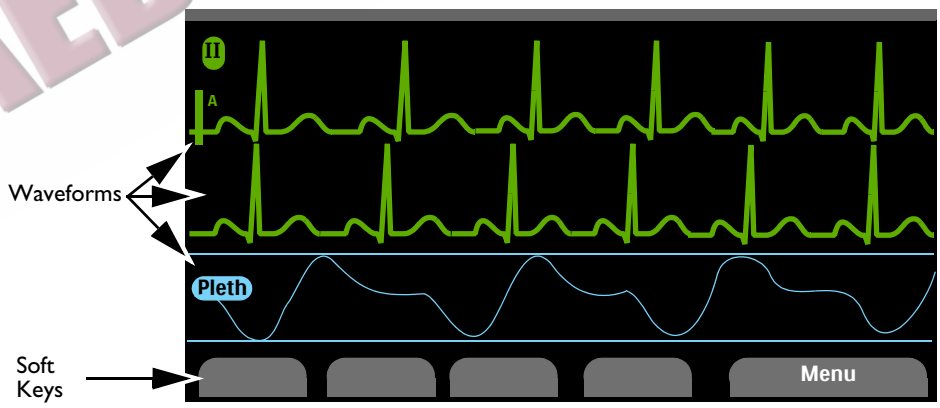
Changing Displayed Waveforms

Wave Sector 1 has a dedicated Lead Select button (see "General Function Buttons" on page 23) to change the displayed lead/source. Waveforms displayed in the other sectors are changed for the current event using the Menu Select button. See "Menus" on page 31.

Soft Key Labels

The four soft key labels correspond to the soft key buttons located immediately below. See Figure 33. These labels change, as appropriate, according to the current display view and function. Soft key labels appearing as gray text indicate the soft key is inactive.

Figure 33 **Waveform and Display Soft Keys Area**



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Menus

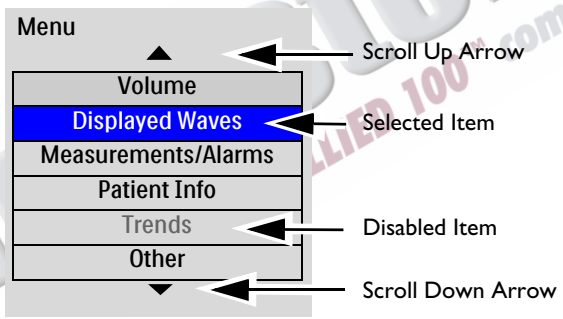
Menus with controls and options specific to each HeartStart XL+ function are easily accessible using the Menu Select and Navigation buttons located on the front panel. Menus are used to adjust volume, select waveforms, select waves for printing, set alarms, enter patient information, generate reports and complete a variety of other tasks.

To display a menu, press the Menu Select button and then use the up or down Navigation buttons to scroll up or down through the available choices until the desired selection is highlighted. The menus have a wrap-around scrolling feature - once you hit the bottom of a menu, it automatically wraps around to the top of the menu and continues scrolling. Holding either end of the Navigation button down accelerates scrolling through the menu choices in that direction.

To make a selection, highlight the menu entry you want and press the Menu Select button. Select Exit to close the menu without making a selection. Arrows at each end of the menu indicate additional list options are available in that direction on the menu. Use the Navigation button to scroll up or down to reveal the remaining options.

Depending upon your given situation, there are times when some options are unavailable for use. Menu choices are grayed out when they are unavailable. They cannot be highlighted or selected. See Figure 34.

Figure 34 **Sample Menu**

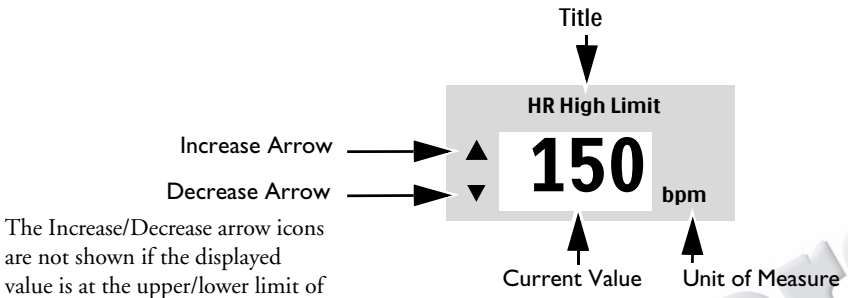


NOTE: Menus are removed from the display when the Charge button is pressed.

Adjusting Numeric Values

Using the HeartStart XL+ Navigation buttons, you can enter numeric values for several parameters, including high and low alarm limits. See Figure 35. The value initially displayed is the default value. Some values are adjustable in increments greater than 1. Hold the Navigation buttons down to accelerate through the numeric values. Release the Navigation button to stop scrolling. To exit, press the Menu Select button.

Figure 35 **Setting Numeric Values**



NOTE: Accelerated scrolling is not available when selecting a low energy (1-10) Joule setting.

Adjusting Volumes

The volume levels for alarms, voice prompts and the QRS indicator are adjustable.

To adjust the volume for the current event:

1. Press the Menu Select button.
2. Using the Navigation buttons, select **Volume** and press the Menu Select button.
3. Select the volume type (**Alarm**, **Voice**, **QRS**) you wish to adjust and press the Menu Select button.

NOTE: You can adjust one volume type without affecting the other volume types. For example, adjusting the QRS volume does not affect the volumes for alarms and voice.

4. Select the new volume level and press the Menu Select button.

The new volume level remains in place for the duration of the current event. Use Configuration Mode to adjust the default volume levels. See "Configurable Parameters" on page 139.

Alarms

The HeartStart XL+ provides various types of alarms indicating changes in patient condition or device/cable conditions that may require attention. Alarms conditions are based on comparisons against preset limits and algorithm results. The HeartStart XL+ breaks alarms into two categories:

Physiological Alarm: An alarm, detected while in a clinical mode, resulting from a patient-related parameter being monitored. **SpO_2 Low** is an example of a physiological alarm. These alarms are not detected in non-clinical modes.

Technical Alarm: An alarm resulting from a equipment-related issue.

All alarms are either latching or non-latching and fall into one of three priority categories. See Table 2.

Table 2 **Alarm Types**

Alarm Type	Condition
High Priority VFIB/VTACH	An immediate response is required. A life-threatening alarm condition is present. A red alarm message is displayed and an alarm tone sounds.
Medium Priority SPO2 LOW	Prompt response is required. A non-life-threatening alarm condition exists. A yellow alarm message is displayed and an alarm tone sounds.
Low Priority Printer Door Open	Awareness is required. A non-life-threatening alarm condition exists. A cyan alarm message is displayed and an alarm tone sounds.
Latching	The alarm remains active regardless if the alarm condition continues to exist or not. A latching alarm is not removed until it is either acknowledged or a higher priority alarm condition occurs.
Non-Latching	The HeartStart XL+ automatically removes the alarm when the alarm condition no longer exists.

NOTES: The presence of multiple alarm conditions at the same time is quite possible. To avoid confusion and to make sure a less serious condition does not hide a more serious condition, the HeartStart XL+ prioritizes and categorizes alarms so the highest priority alarm condition is announced. If multiple same-parameter, same-priority alarms occur, all alarms are displayed one at a time.

Physiological alarms are not detected or displayed in a non-clinical mode. Only technical alarms are displayed in non-clinical modes.

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Clinical Mode Alarm Notification

When in a Clinical Mode, the HeartStart XL+ can be configured to react differently when an alarm condition occurs. See Table 3.

Table 3 **Alarm Notification Types**

Notification	Indication on Display	Indication Status
Alarms On	None	Both visual and audio indications are on.
Alarm Audio Pause	Audio Pause	Only visual indications are on for the duration of the Audio Pause timeframe, which is configurable. When the pause timeframe is complete, both audio and visual indications are on.
Alarm Audio Off	Audio Off	Only visual indications are on.
Alarms Off	Alarms Off	Both audio and visual indications are off for a set period of time.

All alarm conditions are cleared when you switch from a clinical mode to a non-clinical mode.

If you intentionally disconnect a sensor, an alarm sounds. Press the Menu Select button to stop the alarm. The HeartStart XL+ prompts you to confirm your selection. Press the Menu Select button again.

WARNINGS: Silencing either audio or audio and visual indications of active alarms can result in missed alarm conditions and also inhibit indications of new alarm conditions.

Confirm alarm limits are appropriate for the patient each time there is a new patient event.

Do not set alarm limits to such extreme values that render the alarm system useless.

A potential hazard exists if different alarm limits are used for the same or similar equipment in any single area.

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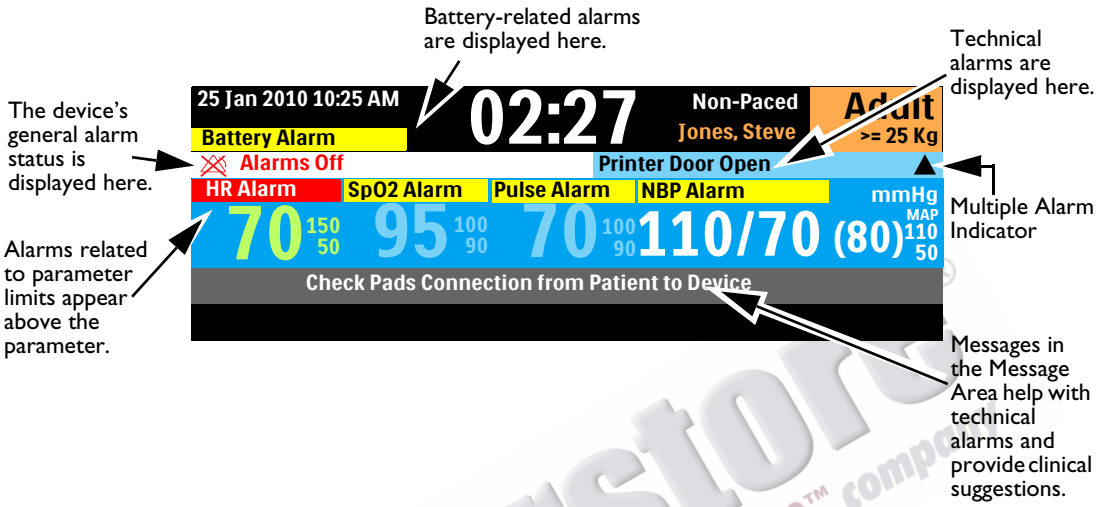
Alarm Notification Display Locations

Depending on the alarm type, the HeartStart XL+ displays notifications in various locations. See Figure 36.

Figure 36 **Alarm Notification Locations**



NOTE: Pacing alarms appear in the Pacing Bar. See "Pacing Alarms" on page 97.

Adjusting Alarm Limits

Alarm limits are preset on the HeartStart XL+ based on its configuration and the patient type. When alarms are on, alarm limits are visible next to the parameter's numeric value. At times, you might want to adjust an alarm limit for the current event.

To adjust an alarm limit:

1. Press the Menu Select button.
2. Select **Measurements/Alarms** and press the Menu Select button.
3. Select the desired parameter and press the Menu Select button.
4. Select the (parameter) **Limits** and press the Menu Select button.
5. Press the top Navigation button to increase the limit. Press the bottom Navigation button to decrease the limit.

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Audio Tones and Alarm Indications

The HeartStart XL+ uses a mixture of audio tones and alarm indications to communicate device and patient status. Table 4 describes the device's audio tones and alarm indications.

Table 4 **Tones and Alarms**

Tone/Indication	Description	Tone level
Single beep	Message. Accompanies a new message on the display - generally informational.	2000 Hz
Continuous tone	Charged. Generated when the the selected defibrillation energy is reached and continues until the Shock button is pressed or the device is disarmed.	2042 Hz
Continuous tone - lower pitch than charged tone	Charging. Generated when the Charge button is pressed and continues until the device is fully charged.	1333 Hz
Periodic chirp	Attention. Generated in instances such as low battery and device failure.	1000 Hz
Tone synchronized with each heart beat	QRS. Single beeps aligned with the QRS. The volume of this tone can be set in Configuration. See Table 29 "General Settings" on page 139.	667 Hz
Continuous tone with alternating pitch	Imminent shutdown. The device will shut down in one minute.	Alternating between 1000 and 2100 Hz
Tone lasting 0.5 second, repeated every second	Philips' high priority alarm tone	960 Hz
	IEC's high priority alarm tone	Meets IEC 60601-1-8
Tone lasting 1 second, repeated every 2 seconds	Philips' medium priority alarm tone	480 Hz
	IEC's medium priority alarm tone	Meets IEC 60601-1-8
Tone lasting 0.25 second, repeated every 2 seconds	Philips' low priority alarm tone	480 Hz
	IEC's low priority alarm tone	Meets IEC 60601-1-8

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Responding to Alarms

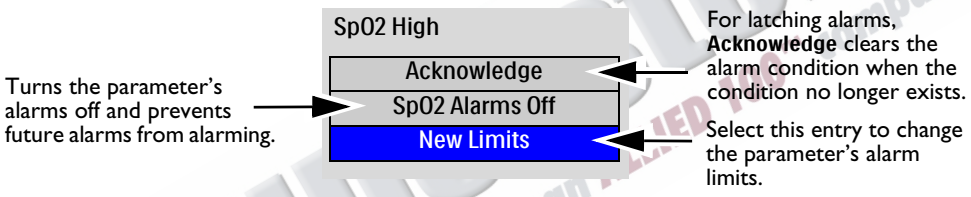
Alarm limits are displayed with each parameter, if alarms for the parameter are on. When an alarm condition occurs there are several ways to respond. Initially:

1. Attend to the patient.
2. Identify the alarm(s) indicated.
3. Silence (pause) the alarm(s). Press the Menu Select button on the front panel of the HeartStart XL+ to acknowledge the alarm and press it again to pause the alarm for the configured pause period while you attend to the patient. If the alarming condition continues to exist, it re-alarms after the configured pause period ends.

   Silencing a specific alarm does not prevent another alarm from sounding. If you silence the second alarm, it resets the pause period for all active alarms.

   If you press the Alarms button, you are silencing all parameter alarms for the configured pause period.
4. Address the alarm condition on the HeartStart XL+ by using the Alarm Response Menu, see Figure 37.

Figure 37 **Sample Alarm Response Menu**


SpO2 High
Acknowledge
SpO2 Alarms Off
New Limits
Turns the parameter's alarms off and prevents future alarms from alarming.
For latching alarms, **Acknowledge** clears the alarm condition when the condition no longer exists.
Select this entry to change the parameter's alarm limits.

NOTE: Alarm history can be accessed in the patient's Event Summary. This information is maintained after powering the device down and in the unlikely event of a power loss. To access this information, see "Event Summary" on page 120.

For more information on alarms and messages as they pertain to a particular functionality, see the specific alarm section in the *HeartStart XL+ Instructions for Use*:

- Heart rate and arrhythmia alarms - see "Heart Rate and Arrhythmia Alarms" on page 54
- AED alarms - see "AED Alarms" on page 71
- Defibrillation alarms - see "Manual Defibrillation Alarms" on page 80
- Cardioversion alarms - see "Cardioversion Alarms" on page 87
- Pacing alarms - see "Pacing Alarms" on page 97
- SpO_2 alarms - see "SpO_2 Alarms" on page 103
- Pulse alarms - see "Pulse Rate Alarms" on page 106
- NBP alarms - see "NBP Alarms" on page 113
- Power alarms - see "Power-Related Alarms" on page 169

Entering Patient Information

Patient information can be entered (except when in AED Mode) for the following categories:

• Name • ID • Sex • Paced Status

To enter patient information on the HeartStart XL+:

1. Press the Menu Select button to activate the Main Menu.
2. Using the Navigation buttons, select **Patient Info** and press the Menu Select button.
3. Select the category you want to enter information for and press the Menu Select button.
4. If you are entering the patient's name, the Last Name screen appears with a menu of letters to enter the patient's last name. See Figure 38. Using the Navigation buttons, select the first letter of the patient's last name.
   a. Press the Menu Select button to select the letter.
   b. Repeat the process with the remaining letters of the last name.
   c. Once you have completed spelling the patient's last name, select **Done**. The HeartStart XL+ stores the last name and prompts you to enter a first name.
5. Repeat Step 4 to insert the patient's first name. Selecting **Done** saves the first name and prompts you to enter a Patient ID.

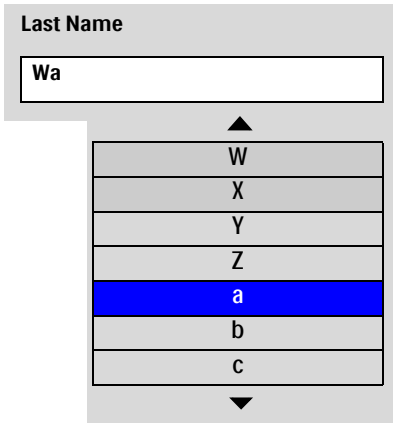
NOTES: If you had previously entered the last name, first name, or patient ID, the HeartStart XL+ remembers the information and populates the screen for you.

There are 18-letter limits for a first name and a last names; 16-character limit for Patient ID.

6. If you are entering the Patient ID, the Patient ID screen appears with a menu of letters and numbers to enter the patient's ID.
7. If you are entering the patient's sex, the sex menu appears with **Male** and **Female** options to select.
8. If you are entering the patient's internal paced status, the Paced Menu appears with **Yes** and **No** options. Select **Yes** if the patient is paced and **No** if they are not paced.

NOTE: It is important to set the patient's correct paced status in order to optimize ECG analysis.

Figure 38 **Entering Patient Name**



Continued Use

Once in a clinical mode, the Continued Use feature is activated. This feature facilitates continued treatment of the same patient by retaining the current settings and patient record when the HeartStart XL+ is turned off for less than 10 seconds. This could occur when turning the knob from Monitor Mode to AED Mode or when the Therapy knob is accidentally moved to the **Off** position. If you turn the HeartStart XL+ back on within 10 seconds, it retains the most recent:

- Alarm settings and conditions
- Wave sector settings
- Event timing
- Volume settings
- Vital Signs Trending data
- Pacing settings
- Synchronized Cardioversion settings
- SpO_2 value
- NBP value and measurement frequency
- Event Summary

NOTES: The Sync feature remains active if the HeartStart XL+ is turned off for less than 10 seconds. However, Sync is disabled when AED Mode is activated and must be turned back on upon returning to Manual Defibrillation Mode.

The Continued Use feature does not function if both battery and external AC power are removed from the device, even briefly.

Passwords

The HeartStart XL+ requires passwords to enter Service Mode and to make certain changes in Configuration Mode. See the *HeartStart XL+ Service Manual* for the Service Mode password. The Configuration Mode password is printed on the front of your *HeartStart XL+ User Documentation* CD-ROM.

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Safety Considerations

The following general warnings and cautions apply to the use of the HeartStart XL+. Additional warnings and cautions specific to a particular feature are provided in the appropriate sections.

WARNINGS: The HeartStart XL+ is not intended to be deployed in settings or situations that promote use by untrained personnel. Operation by untrained personnel can result in injury or death.

Use of the HeartStart XL+ is restricted to a single patient at a time.

Algorithms in the HeartStart XL+ use the currently set Paced Status during rhythm analysis. Confirm that the patient's paced status is correct.

When transporting a patient or carrying the HeartStart XL+, it is important to position it with the display facing away from the body or other surfaces. If not, the Therapy knob may be bumped and inadvertently moved from its desired position.

Never operate the HeartStart XL+ in standing water. Do not immerse or pour fluids on any portion of the HeartStart XL+. If the device does get wet, dry it with a towel.

Do not use the HeartStart XL+ in the presence of a flammable anesthetic mixture or oxygen concentrations greater than 25% (or partial pressures greater than 27.5 kPa/206.27 mmHg). This can cause an explosion hazard.

Avoid connecting the patient to several devices at once. Leakage current limits may be exceeded. Do not use a second defibrillator on the patient while pacing with the HeartStart XL+.

Operating the HeartStart XL+ or its accessories in conditions outside the environmental specifications can result in device or accessory malfunction. The HeartStart XL+ should be allowed to stabilize within the operating temperature range for 30 minutes prior to operation.

The HeartStart XL+ should not be used adjacent to or stacked with other equipment. If adjacent or stacked use is necessary, the HeartStart XL+ should be observed to verify normal operation in the configured use.

Use only 3-wire AC power cords with 3-pronged grounded plugs. For operations in the U.S., the cord must have the proper NEMA-type plug.

Do not touch the communication ports and a patient simultaneously.

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CAUTIONS: Be aware of patient cables, including ECG monitoring equipment when used with high frequency surgical equipment.

Accessory equipment connected to the HeartStart XL+'s data interface must be certified according to IEC Standard 60950 for data-processing equipment or IEC Standard 60601-1 for electromedical equipment. All combinations of equipment must be in compliance with IEC Standard 60601-1-1 systems requirements. Anyone who connects additional equipment to the signal input port or signal output port configures a medical system and is therefore responsible to ensure that the system complies with the requirements of system standard IEC Standard 60601-1-1. If in doubt, contact your local Philips Customer Care Center or local Philips representative.

This device is suitable for use in the presence of high-frequency surgical equipment. Following electrosurgery interference, the equipment returns to the previous operating mode within 10 seconds without loss of stored data. Measurement accuracy may be temporarily decreased while performing electrosurgery or defibrillation. This does not affect patient or equipment safety. See the electrosurgery device's *Instructions for Use* for information on reducing hazards of burns in the event of a defect in its equipment.

Do not expose the HeartStart XL+ to x-ray or strong magnetic fields (MRI).

NOTES: This device and its accessories are not intended for home use.

If you use sterilizable paddles, confirm that they have not reached the end of their sterility before using in an event. See the sterilizable paddles' Instructions for Use.

Keep your HeartStart XL+ Lithium Ion battery charged and a spare battery nearby.

The HeartStart XL+ does not require the practice of any special ElectroStatic Discharge (ESD) precautionary procedures.

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NOTES

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ECG Monitoring

Overview

This chapter describes the HeartStart XL+'s basic ECG and arrhythmia monitoring functions. The device uses Philips' ST/AR Algorithm for ECG analysis.

You can use the HeartStart XL+ to monitor your patient's ECG through:

- multifunction electrode pads.
- 3- or 5-lead ECG monitoring electrode sets.
- external paddles (for quick assessment only, not continuous monitoring).

If both pads and monitoring electrodes are connected, the HeartStart XL+ allows you to select a lead to monitor from either source.

Configurable heart rate and arrhythmia alarms clearly communicate patient status, both audibly and visually.

You can use the HeartStart XL+ to monitor both adult and infant/child ECGs. Use the Patient Category button to switch categories.

When pressing the Patient Category button, all parameter alarm limits change to the new patient category. These changes are retained when you switch modes.

- For patients that are ≥ 25kg or ≥ 8 years old, use Adult patient category.
- For patients <25kg or < 8 years old, use Infant/Child patient category.

  The neonatal patient category is not supported.

ECG waveforms can be acquired through the Therapy port for pads/paddles or the ECG Monitoring port for 3- or 5-lead sets. When you are using 3-lead ECG monitoring, only one ECG lead vector is available. If you are using 5-lead ECG monitoring, up to three ECG lead vectors are available at the same time for display.

WARNINGS: Do not use the HeartStart XL+ to monitor neonatal ECGs. Doing so could result in inaccurate measurements and alarms.

When an external pacemaker is being used on a patient, arrhythmia monitoring is severely compromised due to the high energy level in the pacer pulse. This may result in the arrhythmia algorithm's failure to detect pacemaker non-capture or asystole.

During complete heart block or pacemaker failure (to pace or capture) tall P-Waves (greater than 1/5 of the average R-Wave height) may be erroneously counted by the arrhythmia algorithm, resulting in missed detection of cardiac arrest.

Algorithms in the HeartStart XL+ use the currently set internal Paced Status during rhythm analysis. Confirm that the patient's paced status is correct.

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Preparing to Monitor ECG

You can monitor ECG through multifunction electrode pads or ECG electrodes and do a quick look with external paddles.

NOTE: If monitoring for an extended period of time, monitoring electrodes and multifunction electrode pads may need to be changed periodically. Refer to the manufacturer's documentation for how often to replace the monitoring electrodes or pads.

Skin Preparation

Skin is a poor conductor of electricity so proper skin preparation is important to achieving good electrode/pad-to-skin contact.

To prepare the skin:

1. Identify the appropriate locations:
   For pads – see the pads package.
   For electrodes – see "Electrode Placement" on page 45.
2. If necessary, clip hair at the site or shave if needed.
3. Clean and abrade skin at the site.
4. Dry the site briskly to increase capillary blood flow in the tissues and to remove oil and skin cells.

Monitoring ECG with Pads

To monitor ECG through multifunction electrode pads:

1. If not preconnected, connect the Therapy cable to the HeartStart XL+ as described in "Connecting the Therapy Cable" on page 7.
2. Connect the pads to the Therapy cable as described in "Connecting Multifunction Electrode Pads" on page 8.
3. Prepare the skin as directed above.
4. Apply the pads to the patient as described on the pads package.

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Monitoring ECG with Electrodes

To monitor ECG through electrodes:

1. Prepare the skin.
2. Attach the snaps or grabbers to the electrodes before placing them on the patient.
3. Apply electrodes by peeling them, one at a time, from the protective backing and sticking them firmly to the patient's skin. Press around the entire edge of each electrode to ensure they are secure. Make sure the lead wires do not pull on the electrodes. See "Electrode Placement" for proper electrode locations.
4. If not preconnected, connect the ECG cable as described in "Connecting the ECG cable" on page 9.

WARNING: Be sure the electrodes do not come in contact with other conductive material, especially when connecting or disconnecting the electrodes to/from the patient.

NOTE: Use only approved lead-sets with the HeartStart XL+. Failure to do so may introduce noise and result in intermittent **Cannot Analyze ECG** messages.

Electrode Placement

Figure 39 shows the typical electrode placement for a 3-lead ECG set.

Figure 39 **3-Lead Placement**

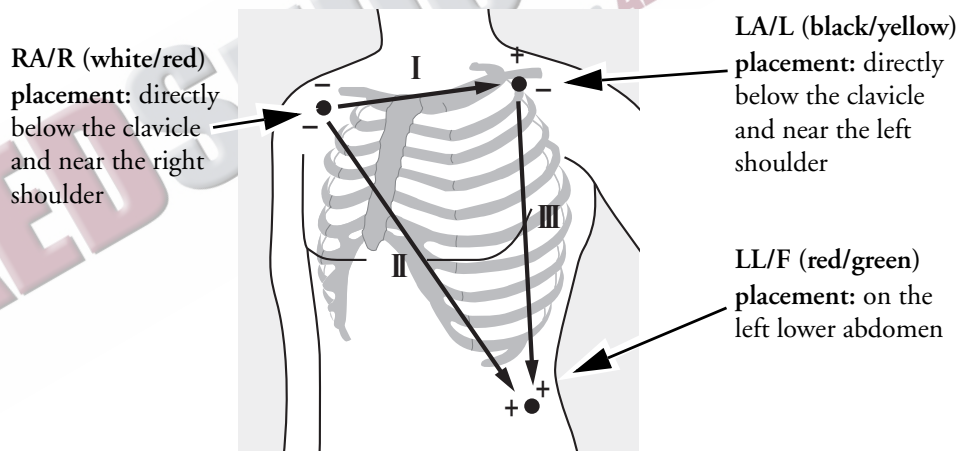
RA/R (white/red) placement: directly below the clavicle and near the right shoulder
LA/L (black/yellow) placement: directly below the clavicle and near the left shoulder
LL/F (red/green) placement: on the left lower abdomen
I
II
III

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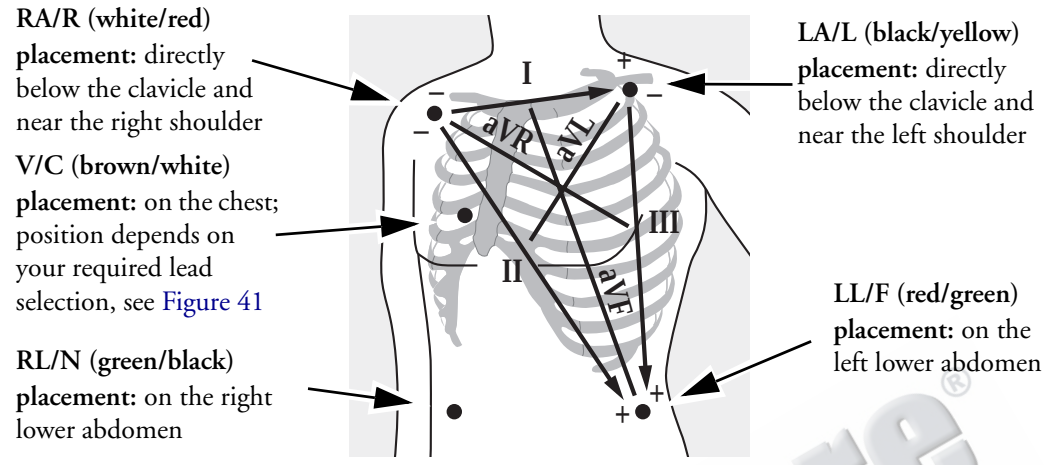
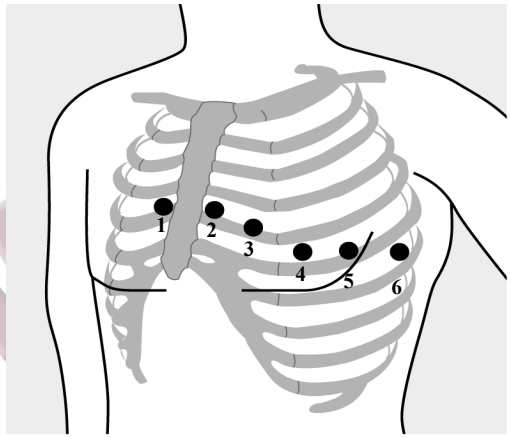
Figure 40 shows the typical electrode placement for a 5-lead ECG set.

Figure 40 **5-Lead Placement**


RA/R (white/red) placement: directly below the clavicle and near the right shoulder
V/C (brown/white) placement: on the chest; position depends on your required lead selection, see Figure 41
RL/N (green/black) placement: on the right lower abdomen
LA/L (black/yellow) placement: directly below the clavicle and near the left shoulder
LL/F (red/green) placement: on the left lower abdomen
I
aVR
aVL
III
II
aVF

The single V/C lead may be placed in any of the precordial electrode positions as shown in Figure 41 (V1/C1 through V6/C6).

Figure 41 **V/C Electrode Placement**



V/C 1 placement: fourth intercostal space at right sternal margin

V/C 2 placement: fourth intercostal space at left sternal margin

V/C 3 placement: midway between V/C 2 and V/C 4

V/C 4 placement: fifth intercostal space at left midclavicular line

V/C 5 placement: same level as V/C 4 on anterior axillary line

V/C 6 placement: same level as V/C 4 at left mid axillary line

NOTES: No matter which V/C electrode placement you select, it appears as V on the HeartStart XL+.

If using a V electrode, it can act as a reference electrode if the RL electrode is unavailable.

For accurate V/C lead placement and measurement, it is important to locate the fourth intercostal space.

To locate the fourth intercostal space:

1. Locate the second intercostal space by first palpitating the Angle of Lewis (small bony protuberance where the body of the sternum joins the manubrium). This rise in the sternum is where the second rib is attached, and the space just below this is the second intercostal space.
2. Palpate and count down the chest until you locate the fourth intercostal space.

Lead Selection

It is important to select a suitable lead for monitoring so that a QRS complex can be accurately detected.

For non-paced patients:

- QRS complex should be tall and narrow (recommended amplitude > 0.5mV).
- R-Wave should be above or below the baseline but not biphasic.
- P-Wave should be smaller than 1/5 R-wave height.
- T-Wave should be smaller than 1/3 R-wave height.

NOTE: To prevent detection of P-Waves or baseline noises as QRS complexes, the minimum detection level for QRS complexes is set at 0.15 mV, according to AAMI-EC 13 specifications. If the ECG signal is too weak, you may get false alarms for asystole.

For paced patients with internal/transvenous pacemakers:

- Confirm paced status is set correctly on the HeartStart XL+, see "Entering Patient Information" on page 38.
- All four criteria for non-paced patients listed above.
- Large enough to be detected (half the height of the QRS complex), with no re-polarization artifact. Some unipolar pacemakers display pace pulses with re-polarization tails which may be counted as QRSs in the event of cardiac arrest or other arrhythmias. Choose a lead to minimize the size of re-polarization tails.

NOTE: Adjusting the ECG wave size on the display does not affect the ECG signal which is used for arrhythmia analysis.

Lead Choices

Available monitoring leads vary depending on what type of ECG cable is connected to the HeartStart XL+ and its configuration. See Table 5.

Table 5 **Lead Choices**

If you are using	These leads are available
a 3-Lead ECG set	I, II, III
a 5-Lead ECG set	I, II, III, aVR, aVL, aVF, V

To select leads to display on the HeartStart XL+, see "Selecting the Waveform" on page 49.

WARNING: Avoid touching monitoring electrodes and other measuring devices when they are applied to the patient. Doing so can degrade safety and may affect results.

CAUTIONS: Beware of patient cables, including ECG monitoring equipment when used with high frequency surgical equipment.

Conductive parts of electrodes and associated connectors for applied parts, including the neutral electrode, should not contact other conductive parts including earth.

NOTES: Signals from TENS or ESU units can cause artifact.

For patients who exhibit intrinsic rhythm only, the risk of missing cardiac arrest may be reduced by monitoring these patients with low heart rate limit at or slightly above the basic/demand pacemaker rate. A low heart rate alarm alerts you when the patient begins pacing. Proper detection and classification of the paced rhythm can then be determined.

When using the ECG Analog Output, detected internal pacemaker pulses are inserted into the output as pulses of less than 3.5 ms in width when measured at 50% of the peak of the pulse. The amplitude of the inserted pulse is >40% and <70% of the detected pacemaker pulse amplitude for pulses widths of 0.5 ms to 2.0 ms.

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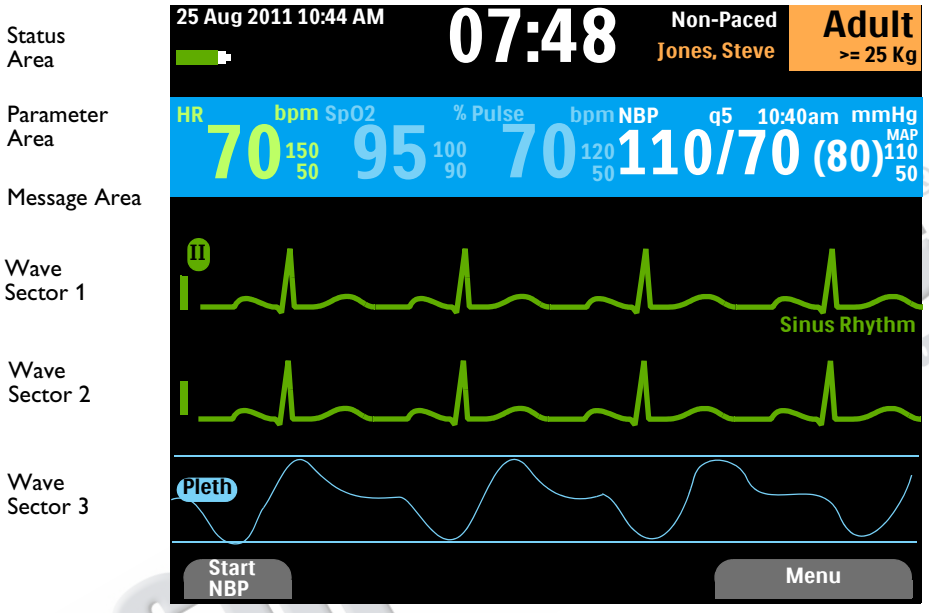
Monitor View

You primarily monitor your patient's ECG waveform in Monitor View by turning the Therapy knob to **Monitor**.

In Monitor View, you can review three waves simultaneously while monitoring all current vital sign parameters. See Figure 42.

Figure 42 **Monitor View Layout**



Selecting the Waveform

The HeartStart XL+ allows you to configure the lead displayed as the primary ECG lead in Wave Sector 1 when the device is turned on. The factory default is Lead II. See Table 33 "Wave Settings" on page 142.

When you first turn the HeartStart XL+ on in Manual Defibrillation, Synchronized Cardioversion or Monitor modes or switch into one of those modes, the default lead is displayed in Wave Sector 1. If the default lead is not available or is of poor quality, the device automatically searches for the ECG lead with the best quality and displays that new lead in Wave Sector 1.

You can also change the waveform for each sector during a patient event.

The ECG wave for Wave Sector 1 is selected through the Lead Select button (see "General Function Buttons" on page 23) or through the Displayed Waves menu. The waves for Wave Sectors 2 and 3 are selected through the Displayed Waves menu only.

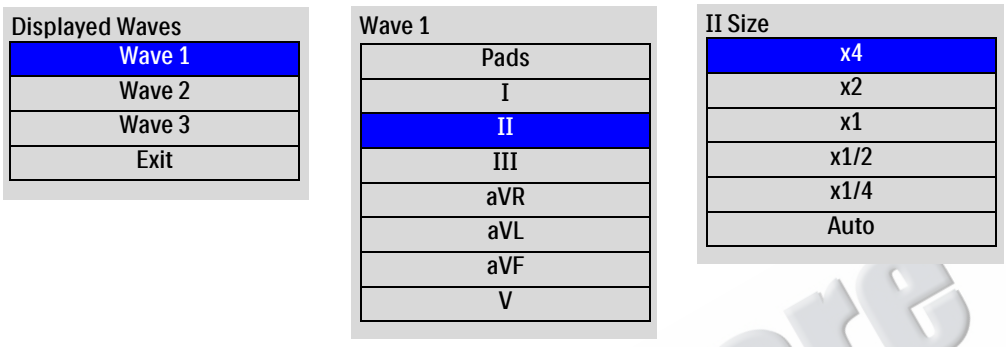
To select a waveform using the Displayed Waves menu:

1. Press the Menu Select button.
2. Using the Navigation buttons, select **Displayed Waves** and press the Menu Select button (see Figure 43).
3. Select the wave sector you want to modify and press the Menu Select button.
4. Select the new wave type you want and press the Menu Select button.

5 If needed, select the appropriate ECG wave size and press the Menu Select button.

NOTE: When you select the ECG wave size for a certain lead, all instances of that lead adjust to the selected size. For example, if you have Lead II selected for both Wave Sectors 1 and 2, and you change the size in Wave Sector 1, Wave Sector 2's size changes automatically.

Figure 43 **Wave Menus**



NOTES: Selecting the **Auto** size, automatically adjusts the ECG size to the maximum size allowed without clipping the wave sector.

Adjusting the ECG wave size on the display only affects the wave size on the display for viewing. It does not affect the ECG signal used for arrhythmia analysis. Detected R-Waves for Synchronized Cardioversion and Demand Pacing are also unaffected by the ECG wave size.

Dashed Lines

A dashed line on your ECG display indicates that you have an invalid ECG signal in the wave sector. You can either troubleshoot the currently selected lead to solve the problem (Table 45 "ECG Monitoring Problems" on page 178) or select a different lead.

To replace a dashed line with a different lead:

In Wave Sector 1 - use the Lead Select button to cycle through available leads and select an appropriate lead.

OR

Use the Displayed Wave menu (see above) to select an appropriate lead.

NOTE: When using a 3-Lead cable, dashed lines will briefly occur with a change of the selected lead.

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Displaying an Annotated ECG

You may choose to display an annotated ECG with arrhythmia beat labels in Wave Sector 2. The same ECG source appearing in Wave Sector 1 is displayed in Wave Sector 2 with a six-second delay. **Delayed** appears near the waveform. White arrhythmia beat labels also appear. See Table 6 for beat label classifications.

Table 6 **Arrhythmia Beat Labels**

Label	Description	Where Displayed
N	Normal	Above QRS
V	Ventricular Ectopic	
P	Paced	
L	Learning Patient's ECG	
?	Insufficient information to classify beats	
‘	Pacer Spike	Above waveform, where pacer spike was detected (If the patient is both atrially and ventricularly paced, the display shows two marks above the waveform aligned with the atrial and ventricular pacing.)
“	Biventricular Pace Pulse	Above waveform where the biventricular pace pulse was detected
A	Artifact (noisy episode)	Above waveform where noise was detected
I	Inoperative condition (e.g. there is a lead off)	Above waveform; at start of a technical alarm, every second of the alarm and at the end
M	Pause, Missed Beat, No QRS	Above waveform where condition detected

To display an annotated ECG:

1. Press the Menu Select button.
2. Using the Navigation buttons, select **Displayed Waves** and press the Menu Select button.
3. Select **Wave 2** and press the Menu Select button.
4. Select **Annotated ECG** and press the Menu Select button.

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Arrhythmia Monitoring

The HeartStart XL+ uses the ST/AR Algorithm. Arrhythmia analysis provides information on your patient's condition, including heart rate and arrhythmia alarms. The HeartStart XL+ uses the ECG lead appearing in Wave Sector 1 for single-lead arrhythmia analysis.

During arrhythmia analysis, the monitoring function continuously:

- Optimizes ECG signal quality to facilitate arrhythmia analysis. The ECG signal is continuously filtered to remove baseline wander, muscle artifact and signal irregularities. Also, if the patient's paced status is set to yes, pace pulses are filtered out to avoid processing them as QRS beats.
- Measures signal features such as R-Wave height, width and timing.
- Creates beat templates and classifies beats to aid in rhythm analysis and alarm detection.
- Examines the ECG signal for ventricular arrhythmias and asystole.

NOTE: Because the ST/AR Algorithm is the HeartStart XL+'s cardiotach source and is needed to generate heart rate and heart rate alarms, the algorithm can never be disabled. However, if desired, arrhythmia and heart rate alarms can be turned off. See "Setting Alarms" on page 56.

ST/AR cardiotach and alarms, when activated, also work in AED mode for ECG monitoring.

Aberrantly-Conducted Beats

As P-Waves are not analyzed, it is difficult and sometimes impossible for the algorithm to distinguish between an aberrantly-conducted supraventricular beat and a ventricular beat. If the aberrant beat resembles a ventricular beat, it is classified as a ventricular beat. You should always select a lead where the aberrantly-conducted beats have an R-Wave that is as narrow as possible to minimize incorrect classifications.

Intermittent Bundle Branch Block

Bundle branch and other fascicular blocks create a challenge for the arrhythmia algorithm. If the QRS complex changes considerably from the learned normal due to bundle branch block, the blocked beat may be incorrectly identified as ventricular, and may cause false PVC alarms. You should always select a lead where bundle branch block beats have an R-Wave that is as narrow as possible to minimize incorrect classifications.

Arrhythmia Learning/Relearning

When arrhythmia monitoring starts, a "learning" process is initiated. The goal is to learn the patient's normal complexes and/or paced complexes (if the patient with an internal/transvenous pacemaker is in paced rhythm). The learning process involves the first 15 valid (non-noisy) beats encountered during the learning phase.

The QRS selected to represent the "normal" complex includes the beat that is the most frequently seen, narrowest, on-time beat. For this reason, learning should not be initiated when the patient's rhythm is primarily ventricular.

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Arrhythmia learning/relearning automatically occurs when:

- The Therapy knob is turned to **Monitor**, **Pacer, AED** or **Manual Defib**.
- Any time there is a change in the lead selection for Wave Sector 1.
- After the correction of a leads or pads off condition that has been active longer than 60 seconds.

Initiate manual relearning if the beat detection is not occurring or if beat classification is incorrect and results in a false alarm. Remember if the same signal condition which caused the algorithm to perform poorly still exists, relearning does not correct the problem. The problem can only be corrected by improving the signal quality (e.g., selecting a different lead).

To initiate relearning manually:

1. Press the Menu Select button.
2. Using the Navigation buttons, select **Measurements/Alarms** and press the Menu Select button.
3. Select **HR/Arrhythmia** and press the Menu Select button.
4. Select **Relearn Rhythm** and press the Menu Select button.

Learning ECG and **Learning Rhythm** messages appear in the bottom portion of Wave Sector 1.

WARNINGS: If arrhythmia relearning takes place during a ventricular rhythm or during a period of poor ECG signal quality, ectopic beats may be incorrectly learned as the normal QRS complex. This may result in missed detection of subsequent events of V-tach and high PVC rates. For this reason you should:

- Take care to initiate arrhythmia relearning only when the ECG signal is noise-free.
- Be aware that arrhythmia relearning can happen automatically.
- Respond to any messages (e.g., if you are prompted to reconnect electrodes).
- Display an annotated wave to ensure the beat labels are correct.

Pacemaker Pulse Rejection: When arrhythmia monitoring paced patients who exhibit only intrinsic rhythm, the monitor may erroneously count paced pulses as QRS complexes when the algorithm first encounters them, resulting in missed detection of cardiac arrest. Be sure that the paced status is set correctly on the device.

Some pace pulses can be difficult to reject. When this happens, the pulses are counted as a QRS complex, and could result in incorrect HR and failure to detect cardiac arrest or some arrhythmias. Keep pacemaker patients under close observation. See Specifications Chapter 18 on page 195 for details on Pacemaker Pulse Rejection Capability.

NOTES: It is important to set the patient's correct paced status in order to optimize ECG analysis.

For more information on arrhythmia analysis, refer to the Application Note *"Arrhythmia Monitoring Algorithm for HeartStart XL+"* available on the Philips website at www.philips.com/ProductDocs.

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Heart Rate and Arrhythmia Alarms

The HeartStart XL+ detects HR and arrhythmia alarm conditions by comparing ECG data to a set of pre-defined criteria. An alarm can be triggered by a rate exceeding a threshold (e.g., HR > configured limit), an abnormal rhythm (e.g., Ventricular Tachycardia) or an ectopic event (e.g., PVC > configured limit).

HR/Arrhythmia alarms can be generated for the conditions shown in Tables 7 and 8. Once generated, they appear as alarm messages in the HR alarm status area above the HR numeric. When ECG alarms are off an **ECG Alarms Off** message appears above the HR numeric. There are both audio and visual alerts. For more information on alarms, see "Alarms" on page 33.

Table 7 **HR/Arrhythmia Physiological Alarms**

Alarm Message	Condition	Type of Alarm	Indication
Asystole	No detectable beats for four seconds in the absence of V-Fib.	High Priority Latching Alarm	Red Alarm message with alarm tone
VFib/VTach	A fibrillatory wave detected for four seconds.		
VTach	Consecutive PVCs and HR exceed configured limits.		
Extreme Brady	Extreme Brady - 10 bpm below HR low limit, capped at 30 bpm.		
Extreme Tachy	Extreme Tachy - 20 bpm above HR High limit, up to 200 bpm (adult)/240 bpm (infant/child). For higher rates, the limit is equal to the HR High limit.		
Pacer Not Capture	No QRS following internal pacer pulse.	Medium Priority Latching Alarm	Yellow Alarm message with alarm tone
Pacer Not Pace	No QRS or pacer internal pulse detected.		
PVC xx > limit/min (detected rate > limit)	The number of detected PVCs in a minute exceed the limit.	Medium Priority Non-Latching Alarm	
HR High	The HR exceeds the configured HR High limit.		
HR Low	The HR is below the configured HR Low limit.		

NOTE: The high HR alarm condition is not detected when the HR High limit is configured greater than the maximum Extreme Tachy threshold. You get the Extreme Tachy alarm. The low HR alarm condition is not detected when the HR Low limit is configured less than or equal to the minimum Extreme Brady threshold.

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Table 8 **HR/Arrhythmia Technical Alarms**

Alarm Message	Condition	Type of Alarm	Indication
Lead/ Pads/ Paddles Off	The multifunction electrode pad/paddles or leads used as the source for Wave Sector 1 during Synchronized Cardioversion may be disconnected or not attached securely.	High Priority Non-Latching Alarm	Red Alarm message with alarm tone
Cannot Analyze ECG	ECG data in Wave Sector 1 cannot be analyzed – an electrode used is disconnected/not attached securely.		
	The analyzing algorithm cannot analyze the ECG signal.		
ECG Equipment Malfunction	A malfunction has occurred in the ECG hardware.		
Pads ECG Equipment Malfunction	A malfunction has occurred in the Pads ECG hardware.		
Equipment Disabled: Therapy	Therapy is disabled due to an equipment failure.		

Figure 44 **Basic Mode Arrhythmia Alarm Priority Chain**

For Monitor, Manual Defibrillation, Synchronized Cardioversion and Pacing

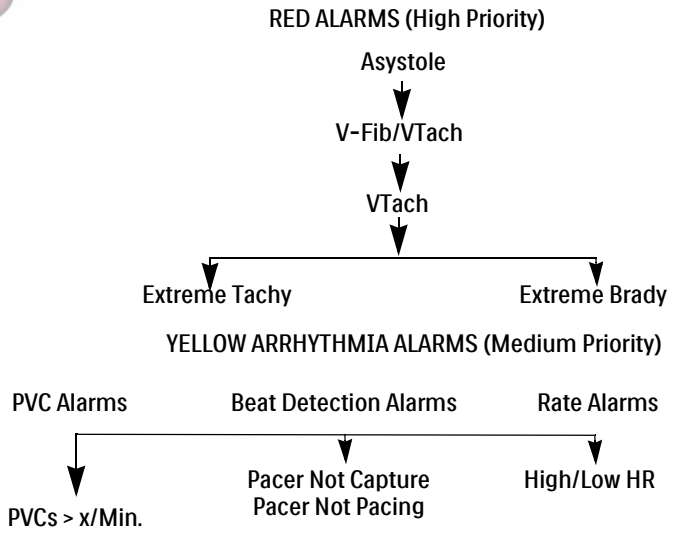

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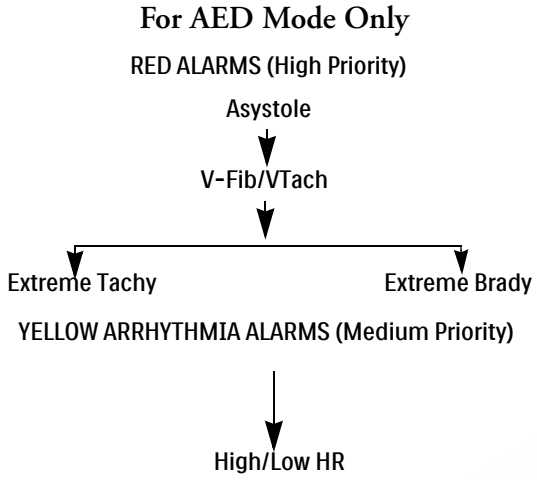
Figure 45 **Cardiotach Mode Arrhythmia Alarm Priority Chain**



Setting Alarms

Alarm settings for Heart Rate (HR), VTach and PVC Rate Limit for the current patient event can be changed via the Menu Select button during the event. Settings for other HR and arrhythmia alarms may not be changed.

Changing Alarm Limits

To change HR, VTach or PVC Rate Limits:

1. Press the Menu Select button.
2. Using the Navigation buttons, select **Measurements/Alarms** and press the Menu Select button.
3. Select **HR/Arrhythmia** and press the Menu Select button.
4. Select the limit you want to adjust and press the Menu Select button.
5. Select the new value and press the Menu Select button.

Enabling/Disabling Alarms

To enable/disable the HR and Arrhythmia alarms:

1. Press the Menu Select button.
2. Using the Navigation buttons, select **Measurements/Alarms** and press the Menu Select button.
3. Select **HR/Arrhythmia** and press the Menu Select button.
4. Select **Alarms On** (**Alarms Off**) and press the Menu Select button.

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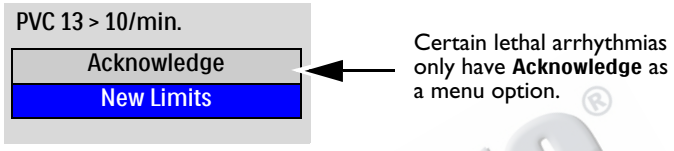
Responding to Alarms

When an alarm occurs, the audio pause label appears above the Navigation and Menu Select buttons. Press either button to silence the alarm audio while you attend to the patient. The alarm reannunciates if the condition continues to exist beyond the configured alarm pause period or another alarm condition occurs.

After pausing the audio on the HeartStart XL+, attend to the patient and press the Menu Select button to acknowledge the alarm condition. If required, adjust the alarm limits using the Menu Select and Navigation buttons.

Figure 46 **Sample Alarm Response Menu**



HR/Arrhythmia Alarms in AED Mode

If alarms are turned on in AED Mode, all Technical Alarms listed in Table 8 and the following Physiological Alarms from Table 7 are generated when the condition exists:

- Asystole
- Extreme Tachy
- HR High
- V-Fib/Tach
- Extreme Brady
- HR Low

For more information on AED Mode, see "AED Mode" on page 59.

For more information on Alarms see "Alarms" on page 33.

Troubleshooting

If your HeartStart XL+ does not operate as expected during ECG and Arrhythmia monitoring, see Table 45 "ECG Monitoring Problems" on page 178.

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NOTES

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5

AED Mode

Defibrillation therapy is the definitive method for termination of lethal arrhythmias. The HeartStart XL+'s Semi-Automated External Defibrillation (AED) Mode is designed to guide you through standard treatment algorithms for cardiac arrest. The HeartStart XL+ provides therapy through the application of a brief biphasic pulse of current to the heart. This energy is transferred through disposable multifunctional pads applied to the patient's bare chest.

This chapter describes how to use AED Mode. It explains the voice and visual prompts that guide you through the defibrillation process and describes how prompts vary depending upon the condition of the patient and the configuration of your device. Configuration choices allow you to customize AED Mode to better meet the unique needs of your institution or resuscitation team.

The HeartStart XL+ uses Philips' SMART Analysis algorithm as the basis for making a shock decision in AED Mode. The SMART Analysis algorithm was designed to make aggressive shock decisions concerning ventricular fibrillation. Because ventricular tachycardia rhythms may have an associated pulse, SMART Analysis is more conservative when making shock decisions with these rhythms.

Besides resuscitating a patient, in AED Mode you can also monitor the patient's ECG, SpO_2 and pulse. Certain ECG alarms can also be displayed in AED Mode. Even though ECG alarms, which are obtained through the ST/AR Algorithm, can be viewed in AED Mode, the SMART Analysis algorithm is used as the only basis for determining a shock. See "Other Alarms in AED Mode" on page 72.

The HeartStart XL+ AED Mode can be used on both adult and infant/child patients. Use the Patient Category button to switch categories.

When pressing the Patient Category button, all parameter alarm limits change to the new patient category. These changes are retained when you switch modes.

- For patients that are ≥ 25kg or ≥ 8 years old, use Adult patient category.
- For patients <25kg or < 8 years old, use Infant/Child patient category.

The neonatal patient category is not supported in AED Mode.

For information on annotating, storing, exporting and printing event information acquired in AED Mode, see "Data Management" on page 119.

For information on setting AED configuration choices, see "Defib/Sync/AED Settings" on page 143.

Optional SpO_2 and Pulse monitoring are also available in AED Mode. For more information, see "SpO_2 and Pulse" on page 72 and Chapter 9 "Pulse Oximetry" on page 99.

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Precautions for AED Therapy

WARNINGS: The AED algorithm is not designed to handle erratic spiking problems caused by a properly or improperly functioning pacemaker. In patients with cardiac pacemakers, the HeartStart XL+ may have reduced sensitivity and not detect all shockable rhythms.

Use only pads that are approved for use with the HeartStart XL+. Use of non-approved pads could affect performance and results. See Table 51 for a list of supported pads.

For adults in AED Mode, the multifunction electrode pads must be in the anterior-apex position shown on the packaging. For Infant/Child patients, the pads can be in the anterior-posterior position.

Do not allow multifunction electrode pads to touch each other or to touch other ECG monitoring electrodes, lead wires, dressings, etc. Contact with metal objects may cause electrical arcing and patient skin burns during defibrillation and may divert current away from the heart.

During defibrillation, air pockets between the skin and multifunction electrode pads may cause patient skin burns. To help prevent air pockets, make sure the pads completely adhere to the skin. Do not use dried out pads. Do not open pads package until just prior to use.

Never touch the patient or any equipment connected to the patient (including the bed or gurney) during analysis and defibrillation.

Avoid contact between the patient and conductive fluids and/or metal objects such as the gurney.

Medical electrical equipment which does not incorporate defibrillator protection should be disconnected before defibrillation.

NOTES: Successful resuscitation depends on many variables specific to the patient's physiological state and the circumstances surrounding the patient event. Failure to have a successful patient outcome is not a reliable indicator of defibrillator/monitor performance. The presence or absence of muscular response to the transfer of energy during electrical therapy is not a reliable indicator of energy delivery or device performance.

Impedance is the resistance found between the defibrillator's pads when applied to the patient's body the device must overcome to deliver an effective discharge of energy. The degree of impedance differs from patient to patient and is affected by several factors including the presence of chest hair, moisture and lotions or powders on the skin. The low-energy SMART biphasic waveform is an impedance-compensating waveform that is designed to be effective across a wide range of patients. However, if you receive a **Shock Aborted** message on the display, check that the patient's skin has been washed and dried and that any chest hair has been clipped. If the message persists, change the pads and/or Therapy cable.

The HeartStart XL+ 's SMART Analysis algorithm detects internal pacemaker pulses that are 2.5 ms or less in duration and removes these pulses so that they are not counted by the algorithm.

Perform all routine diagnostic tests to verify that voice prompts are operational during Operational Check and according to your organization's protocol.

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AED View

When the Therapy knob is moved to **AED**, AED View is displayed (see Figure 47). AED Mode-related information includes:

AED Message Area: Displays important messages for the user while in AED Mode.

Shock Counter: Displays the number of shocks for the current event (including shocks delivered in Manual Defibrillation Mode)

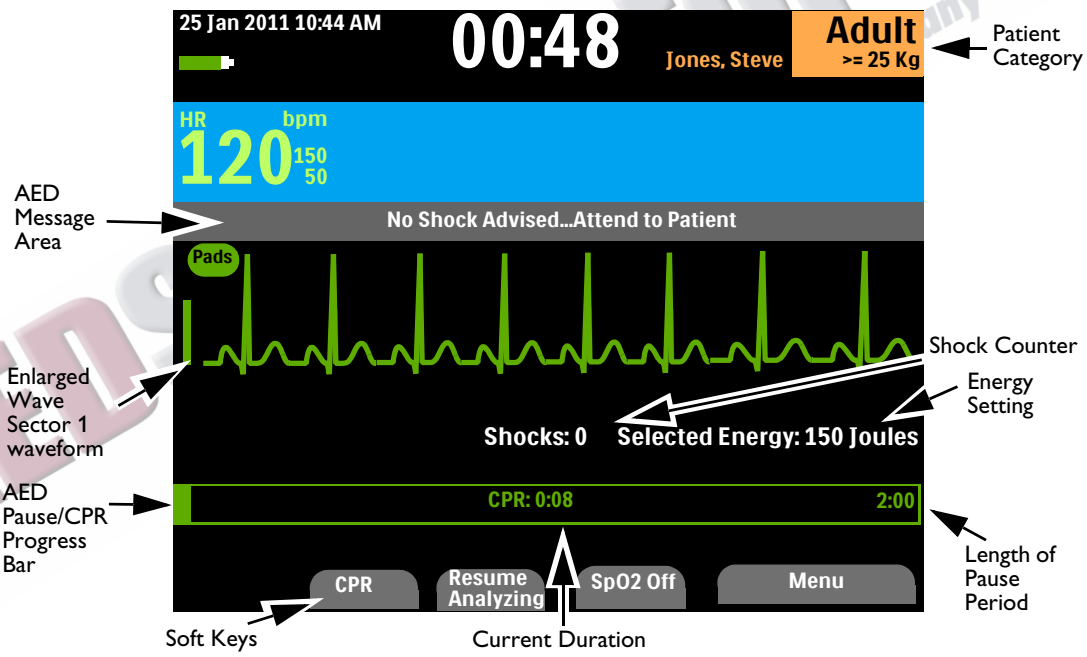
Configured Energy: Displays the configured energy for the current patient category.

Wave Sector 2: Displays the SpO_2 waveform (if your device has the option and is configured to do so) or the AED Pause/CPR Progress Bar.

AED Pause/CPR Progress Bar: When in use, replaces the wave in Wave Sector 2 and tracks the progress of the analysis pause and CPR periods.

Patient Category: Displays the current Patient Category. The patient category triggers specific alarm limits and AED energy settings for defibrillation.

Figure 47 **AED View Layout**



NOTE: Only the ECG acquired through multifunction electrode pads is displayed in AED Mode.

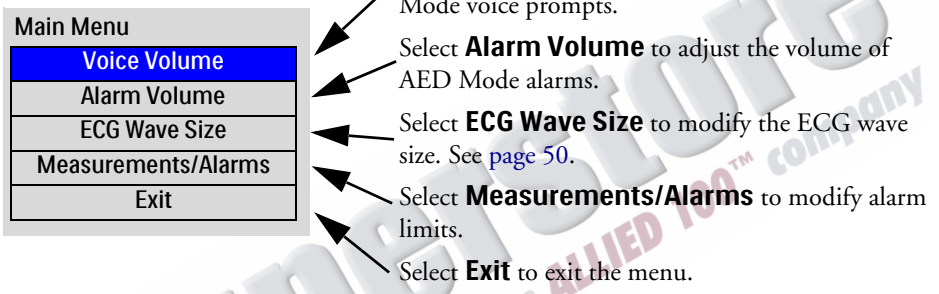
AED Soft Keys

AED Mode has four soft keys available (see Figure 47):

- **CPR** - Pressing the **CPR** soft key initiates the configured pause period to perform CPR.
- **Resume Analyzing** - Pressing the **Resume Analyzing** soft key initiates the AED analysis algorithm to resume or restart analysis.
- **SpO_2 On/Off**- Available if you have the SpO_2 option installed and AED SpO_2 monitoring enabled. Pressing the **SpO_2** soft key turns SpO_2 monitoring on or off.
- **Background Analysis** - This key is available if your device is configured for No Shock Advised (NSA) Monitoring and you have activated NSA Pause. Press it to begin NSA monitoring.

Pressing the Menu Select button brings up the main menu for AED Mode. See Figure 48.

Figure 48 **AED Main Menu**


Main Menu
Voice Volume
Alarm Volume
ECG Wave Size
Measurements/Alarms
Exit
Select Voice Volume to adjust the volume of AED Mode voice prompts.
Select Alarm Volume to adjust the volume of AED Mode alarms.
Select ECG Wave Size to modify the ECG wave size. See page 50.
Select Measurements/Alarms to modify alarm limits.
Select Exit to exit the menu.

For more information on menus, see "Menus" on page 31.

NOTE: In loud environments, use the display prompts in addition to the voice prompts.

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Using AED Mode to Defibrillate

Preparation

◎ **To prepare for defibrillation in AED Mode:**

1. Confirm the patient is:
   - Unresponsive
   - Not breathing
   - Pulseless
2. Expose patient's bare chest. Wipe moisture from the patient's chest and, if necessary, clip or shave excessive chest hair.
3. Check the expiration date on the pads package and inspect the package for any damage.
4. Connect the Therapy cable to the HeartStart XL+ (see "Connecting the Therapy Cable" on page 7).
5. If the pads are not expired and package is undamaged, open the package and connect the pads connector to the end of the Therapy cable (see "Connecting Multifunctional Pads" on page 8).
6. Apply the pads to the patient as directed on the pads packaging or according to your organization's protocol.

NOTE: If you are using Philips' HeartStart Preconnect Pads (989803166021), the pads may already be connected to the end of the Therapy cable. Open the package to apply the pads to the patient.

CAUTION: Aggressive handling of multifunction electrode pads in storage or prior to use can damage the pads. Discard the pads if they become damaged.

Operation

◎ **To operate the HeartStart XL+ in AED Mode:**

1. Turn the Therapy knob to **AED**. The HeartStart XL+ announces and displays the current patient category.
   If not correct, use the Patient Category button to select the appropriate patient category.
   - For patients that are ≥ 25kg or ≥ 8 years old, use Adult patient category.
   - For patients <25kg or < 8 years old, use Infant/Child patient category.
2. Follow the voice and screen prompts.
3. Press the orange Shock button if prompted.

See the following sections for more information.

NOTE: While operating in AED Mode, the capabilities of the device are limited to those essential to the performance of semi-automated external defibrillation. Only the ECG acquired through pads is displayed. If you have the SpO_2 option and it is configured to display the numeric in AED Mode, the Pleth waveform is also displayed. Previously set alarms and scheduled NBP measurements are indefinitely paused and entry of patient information (with the exception of patient category) is disabled. Additionally, the Sync, Lead Select and Alarm Pause buttons are inactive.

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Step 1 - Turn the Therapy Knob to AED

When the HeartStart XL+ is turned to **AED**, it announces and displays the patient category.

Confirm you have the correct category active for the patient. If not, use the Patient Category button to select the correct category.

The device also checks to see if the Therapy cable and multifunction electrode pads are properly connected. If the:

- Therapy cable is not properly attached, you are prompted to "Plug in Connector" with a **Connect Pads Cable** prompt and graphic illustration on the screen.
- Multifunction electrode pads are not connected to the Therapy cable, pads are not applied to the patient or pads are not making proper contact with the patient's skin, you are prompted to "Insert connector firmly. Apply pads".

Follow the audio and visual prompts to correct the issues. When properly connected, AED Mode automatically begins.

Step 2 - Follow Screen and Voice Prompts

Once an ECG is detected through the multifunction electrode pads, the HeartStart XL+ warns you not to touch the patient and automatically analyzes the patient's heart rhythm.

NOTE: The AED algorithm only looks at the ECG for analysis. It does not use SpO_2 data, even if the option is active in AED Mode.

WARNING: Handling or transporting the patient during ECG rhythm analysis can cause an incorrect or delayed diagnosis. Under these circumstances, if the HeartStart XL+ issues a "Shock Advised" command, keep the patient as still as possible for at least 10 seconds so the device can reconfirm the rhythm analysis before pressing the orange Shock button to deliver a shock.

The AED Mode algorithm can return one of the following results:

- **Shock Advised** - If a shockable rhythm is detected, the HeartStart XL+ automatically charges to the preconfigured Joule setting (default is 150J) if the Adult patient category is selected (see "Defib/Sync/AED Settings" on page 143) or 50J if in the Infant/Child category. Charging is accompanied by voice and screen prompts. When the device is fully charged, a steady high-pitched tone sounds, and the orange Shock button flashes.

  Heart rhythm analysis continues while the HeartStart XL+ charges. If a rhythm change is detected before the shock is delivered, and a shock is no longer appropriate, the defibrillator disarms itself.

NOTE: When fully charged, you can disarm the device at any time by turning the Therapy knob off the **AED** position. Resume AED monitoring by turning the Therapy knob back to **AED**.

- **No Shock Advised** (NSA) - If a shockable rhythm is not detected, the HeartStart XL+ tells you "No shock advised." Follow your institution's protocol for a No Shock Adviced alert. The device's next steps are determined by the No Shock Advised Action configuration choice. If the configuration is set to:

  - **Monitor** - The HeartStart XL+ monitors the ECG and automatically resumes analysis if a potentially shockable rhythm is detected. You are periodically prompted to press **[CPR]** and to begin CPR if CPR is indicated. The frequency of these prompts is defined in the Monitor Prompt Interval configuration choice. You may press **[CPR]** to suspend monitoring and administer CPR. The pause period is defined by the CPR Timer configuration choice. See "Defib/Sync/AED Settings" on page 143.

- **Pause Time** - Analysis is suspended for the specific period which is defined by the NSA Action configuration choice. You may attend to the patient and administer CPR if indicated. The Pause Status Bar is displayed (see "AED View Layout" on page 61). At the end of the pause period, the HeartStart XL+ resumes analyzing.

- **ECG cannot be analyzed** - If artifact interferes with analysis, the HeartStart XL+ alerts you and attempts to continue analyzing. If artifact persists and device announces that the ECG can't be analyzed, it enters a pause period.

  While paused, analysis is suspended. Check that the pads are making proper contact with the patient's skin and minimize movement. Analysis resumes automatically in 30 seconds or when you press the **[Resume Analyzing]** soft key. You should always use the analyze function to determine if a rhythm is shockable.

For more information on AED messages, see "AED Mode User Messages" on page 66.

Step 3 - Press Shock Button if Prompted

Once charging is complete, the HeartStart XL+ prompts you with "**Deliver shock now.**" Make sure no one is touching the patient or anything connected to the patient. Call out clearly and loudly "Stay Clear!' Then press the flashing orange Shock button to deliver a shock to the patient.

WARNINGS: The Shock button must be pressed to deliver a shock. The HeartStart XL+ does not automatically deliver a shock.

Defibrillation current can cause operator or bystander injury. Do not touch the patient or equipment connected to the patient during defibrillation.

Delivery of the shock is confirmed by an **Attend to Patient. Shock Delivered** visual message and the shock counter is updated to reflect the number of shocks given. The defibrillator then announces "**Begin CPR**" and enters the configured CPR Timer period. Prompts may be brief or detailed as defined by the Voice Prompt configuration choice. Analysis begins again at the end of the pause period or when you press the **[Resume Analyzing]** soft key.

NOTES: Once prompted to administer the shock, if you do not do so within the configured Auto Disarm time interval, the HeartStart XL+ disarms itself and enters a pause period for CPR. The device resumes analyzing at the end of the pause period or when you press the **[Resume Analyzing]** soft key.

Rhythm monitoring is intended to provide a backup or secondary measure of potentially shockable rhythms in various environments but is not a substitute for being attentive to the patient's state.

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AED Mode User Messages

AED Mode guides you through the defibrillation process. Depending upon the given situation, voice prompts and display messages are presented to assist you in using the mode. See Tables 9-16.

Table 9 AED Mode Connect Pads Messages

This message may appear when the Therapy cable is not connected properly to the HeartStart XL+.

Audio Message	Display Text	Condition	User Action
"Plug in Connector"	**Connect Pads Cable**	The Therapy cable is not connected to the HeartStart XL+.	Securely connect the Therapy cable to the device.

Table 10 AED Mode Messages

These messages may appear during normal AED Mode operation.

Audio Message	Display Text	Condition	User Action
"Adult Mode"	**Adult** **>=25 Kg**	The current AED Mode patient category is Adult.	None
"Infant/Child Mode"	**Infant/Child** **< 25 Kg**	The current AED Mode patient category is Infant/Child.	None
"Low battery"	See battery icon in upper left of the display.	The HeartStart XL+ battery charge level is low.	Charge the battery or replace it with a charged battery.

Table 11 AED Mode Analysis Related Messages

These messages may appear during AED analysis.

Audio Message	Display Text	Condition	User Action
"Stay clear of patient. Analyzing. Stay clear."	**Stay Clear of Patient, Analyzing**	ECG analysis is underway.	Do not touch the patient.
"No shock advised"	**Attend to Patient, No Shock Advised**	ECG analysis has determined the rhythm is not shockable.	Attend to the patient. Begin CPR if indicated.
"Shock advised"	**Stay Clear of Patient. Shock Advised**	ECG analysis has determined the rhythm is shockable.	Once the device is charged, press the flashing orange Shock button.
"Stay clear, shock advised"			
"Analyzing Interrupted. Stay clear of patient. Stop all motion"	**Stay Clear of Patient, Analyzing Interrupted**	ECG analysis was interrupted because of a bad ECG signal.	Stop patient movement and reanalyze.
"Cannot analyze"	**Cannot Analyze**	ECG analysis cannot determine if the rhythm is shockable or not.	Check pads connection. Attend to patient, begin CPR if indicated.

Table 12 **AED Mode Pads Off Messages**

These messages may appear when the multifunction electrode pads are not secured to the patient.

Audio Message L = long prompts S = short prompts Not noted = Both	Display Text	Condition	User Action
L - "Insert connector firmly. Apply pads to patient's bare chest" S-"Insert connector firmly. Apply pads" "Apply Pads" is repeated four times or until the connection is made.	**Insert Connector, Apply Pads**	With Adult patient category selected, there is no connection between the pads and the Therapy cable.	Securely connect the Therapy cable and the pads connector. See "Connecting Multifunction Electrode Pads" on page 8.
"Insert connector firmly. Look carefully at the screen for Infant/Child pad placement"		With Infant/Child patient category selected, there is no connection between the pads and the Therapy cable.	
"Apply pads as shown on screen. Apply first pad to child's chest. Apply second pad to child's back. Apply pads as shown on screen"		With Infant/Child patient category selected, if pads remain disconnected, more audio prompts follow.	
"Press pads firmly to patient's bare skin. Pads must not be touching clothing or each other. If needed, remove hair from patient's chest."	**Press Pads Firmly**	The Therapy cable is connected. A pads off condition still exists.	Securely connect the Therapy cable and the pads connector. See "Connecting Multifunction Electrode Pads" on page 8.
"Be sure pads connector is completely inserted"			Confirm there is a good pads contact with the skin.
"Poor pads contact, Replace pads"	**Poor Pads Contact**		Replace the pads.
"Begin CPR"	**Press The CPR Button And Begin CPR**		Begin CPR, if indicated.

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Table 13 AED Mode Marginal Impedance Messages

These messages may appear when the HeartStart XL+ detects a higher pad impedance than expected in the average patient. The cause could be a hairy chest, you are using old pads or the pads may not be fully on the patient.

Audio Message	Display Text	Condition	User Action
"Press pads firmly to patient's bare skin"	**Press Pads Firmly**	When the device is not charged, charging or delivering a shock or in a pause period, pads impedance condition is marginal.	Recheck pads. Confirm they are securely connected to the patient.
"Press pads firmly to patient's bare skin. Pads must not be touching clothing or each other. If needed remove hair from patient's chest"			
"Poor pads contact, Replace pads"	**Poor Pads Contact**		Recheck pads. Confirm they are securely connected to the patient. If they are, remove them and replace with new pads.
"Begin CPR"	**Press The CPR Button And Begin CPR**		Good pads contact cannot be established. If CPR is indicated, begin CPR.

Table 14 AED Mode Low Impedance Messages

These messages may appear when the HeartStart XL+ detects a lower pad impedance than expected in the average patient. The cause could be that the pads are touching or there is too much moisture on the patient.

Audio Message	Display Text	Condition	User Action
"Poor pads contact. Apply pads as shown on screen"	**Reapply Pads to Dry Chest**	When the device is not in a pause period, the pads are detecting a low impedance.	Confirm there is a good pads contact with the skin.
"Poor pads contact, Replace pads"	**Poor Pads Contact**		Recheck pads. Confirm they are securely connected to the patient. If they are, remove them and replace with new pads.
"Begin CPR"	None		Good pads contact cannot be established. If CPR is indicated, begin CPR.

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Table 15 **AED Mode Shock Related Messages**

These messages may appear when a shock is advised or immediately after a shock is delivered in AED Mode.

Audio Message	Display Text	Condition	User Action
"Deliver shock now"	**Deliver Shock Now**	The defibrillator is charged and waiting for you to press the Shock button.	Press the flashing orange Shock button.
"Press the flashing orange button now"	**Press Orange Button**		
"Shock cancelled"	None	After charging, the device detected a non shockable rhythm and automatically disarmed.	Attend to the patient.
"Shock cancelled, No shock advised"			
"Shock cancelled. Pads must not be touching clothing or each other."		A shock was aborted due to low impedance.	Confirm pad placement is correct and pressed firmly against the chest then try shocking again.
"Shock cancelled. Press pads firmly to patient's bare skin."		A shock was aborted due to high impedance.	
"Shock delivered"		A shock has been delivered to the patient.	Attend to the patient.
"Press pads firmly to patient's bare skin."		Shock delivered abnormal energy due to marginal impedance.	Confirm pad placement is correct and pressed firmly against the chest.
None	**Attend to Patient, Shock Delivered**	The final shock in a series has been delivered.	Attend to the patient.
None	**Stay Clear of Patient, Shock Delivered**	A shock in a yet-to-be-completed series has been delivered.	Stay clear of patient.

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Table 16 **AED Mode Forced Pause Related Messages**

These messages may appear during a forced pause time period when analysis is not taking place and you can attend to the patient.

Audio Message	Display Text	Condition	User Action
"Begin CPR"	**Attend to Patient**	A shock series has ended and the device has entered a pause period for CPR.	Attend to the patient. Begin CPR if indicated.
		A no shock decision has been made and the device has entered a pause period for CPR.	
	Attend to Patient, Monitoring	A no shock decision has been made and during monitoring, artifact has been detected.	
"Attend to patient	**Attend to Patient**	You have paused the device.	
"No shock advised"	**Attend to Patient, no Shock Advised**	A no shock decision has been made and the device has entered a pause period for CPR.	
"Begin CPR, Check patient"	None		
"Stop CPR"	None	The CPR pause period has ended.	Attend to patient. Resume analysis if indicated.

Using AED Mode to Monitor

You can use AED Mode to monitor your patient's ECG, SpO_2 and pulse. Related alarms can also be activated for the parameters.

To monitor ECG in AED Mode and activate alarms:

1. Turn the Therapy knob to **AED**. The HeartStart XL+ announces the patient category currently set. If not correct, use the Patient Category button to select the appropriate patient category.
   - For patients that are ≥ 25 kg or ≥ 8 years old, use Adult patient category.
   - For patients <25 kg or < 8 years old, use Infant/Child patient category.
2. After performing an initial ECG rhythm analysis, if the rhythm is not shockable, the HeartStart XL+ begins to monitor the patient.
3. To activate ECG alarms in AED Mode, press the Alarms button on the front of the HeartStart XL+.

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To monitor optional SpO_2 and pulse in AED Mode and activate alarms:

1. Once in AED Mode, attach an SpO_2 sensor to the patient (see "Applying the Sensor" on page 101).
2. If you have the device configured to monitor SpO_2 in AED Mode, SpO_2 monitoring begins once a pulsatile reading is obtained. For more information on SpO_2, see Chapter 9 "Pulse Oximetry" on page 99.
3. To activate SpO_2 and Pulse alarms in AED Mode, press the Alarms button on the front of the HeartStart XL+.

Configurable Resuscitation Protocols

In AED Mode, you have the flexibility to configure the HeartStart XL+ to match your institution's resuscitation protocols. You can:

- Customize the device for the number of shocks (1-4) in a series.
- Select the energy setting within a given shock series.
- Set the CPR Pause interval from 1-3 minutes.

For more information, see Tables 34 and 35 in the Configuration chapter.

AED Alarms

The SMART Analysis algorithm generates AED Defibrillation alarms for the conditions shown in Table 17. There are both audio and visual alerts, when turned on.

When monitoring a patient, the ST/AR ECG Monitoring Algorithm generates ECG alarms in AED Mode, if turned on. See "Other Alarms in AED Mode" below.

For more information on alarms, see "Alarms" on page 33.

Table 17 **AED Defibrillation Alarms**

Alarm Message	Condition	Type of Alarm	Indication
Pads Off	With pads in use, the connection between the device and patient has been lost.	High Priority Non-Latching Alarm	Red Alarm message with alarm tone
Shock Aborted	A shock has been automatically aborted.	High Priority Latching Alarm	
Abnormal Shock Dose Delivered	Abnormal shock dose delivered due to marginal patient impedance.		
Pads/Paddle Type Unknown	The device detected a change in paddles or pads type or the therapy cable identification is invalid.		
Equipment Disabled: Therapy	Therapy is disabled due to an equipment failure.		

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Other Alarms in AED Mode

ECG

If ECG alarms are turned on in AED Mode, all Technical Alarms listed in "HR/Arrhythmia Technical Alarms" on page 55 and the following Physiological Alarms from "HR/Arrhythmia Physiological Alarms" on page 54 are generated when the condition exists:

- Asystole
- V-Fib/Tach
- Extreme Tachy
- Extreme Brady
- HR High
- HR Low

Once generated, all alarms appear as messages in the HR alarm status area above the HR numeric. There are both audio and visual alerts. For more information on ECG alarms, see "Arrhythmia Monitoring" on page 52.

SpO_2 and Pulse

If SpO_2 and Pulse alarms are turned on, once generated the alarm messages appear in the SpO_2 or Pulse status area above their respective numeric. For more information on these alarms see "SpO_2 Alarms" on page 103 and "Pulse Rate Alarms" on page 106.

Troubleshooting

If your HeartStart XL+ does not operate as expected during AED Mode, see Table 46 "Defibrillation and Pacing Problems" on page 180.

If there is a delay in delivering therapy, start CPR if indicated.

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6

Manual Defibrillation

This chapter explains how to prepare for and perform defibrillation or asynchronous cardioversion on the HeartStart XL+ using multifunction electrode pads, external paddles and internal paddles.

See Chapter 7 “Cardioversion” on page 81 for information on synchronized cardioversion.

Overview

Defibrillation therapy is the definitive method for termination of lethal arrhythmias.The HeartStart XL+ provides this therapy through the application of a biphasic pulse of current to the heart. This electrical energy is transferred through attached paddles or disposable multifunction electrode pads applied to the patient’s bare chest. Internal paddles for open-chest intrathorasic defibrillation can also be used.

In Manual Defibrillation Mode, the entire defibrillation process is under your control. You must assess the ECG, decide if defibrillation or cardioversion is indicated, select the appropriate energy, charge the HeartStart XL+ and deliver the shock. Text messages on the display provide relevant information throughout the process. Be attentive to these messages when displayed.

The ECG strip and Event Summary are easily annotated with information using the Mark Event button. See “Mark Events” on page 134.

Monitoring alarms are available in Manual Defibrillation Mode but they are turned off by default.

To activate alarms, press the Alarm button . Alarms are reactivated once the Therapy knob is moved to **Monitor**, an energy setting or **Pacer** or the **Sync** button is pressed.

The HeartStart XL+ Manual Defibrillation Mode can be used on both adult and infant/child patients. Use the Patient Category button to switch categories.

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Precautions for Manual Defibrillation

WARNINGS: Defibrillating asystole can inhibit the recovery of natural pacemakers in the heart and completely eliminate any chance of recovery. Asystole should not be routinely shocked. Begin CPR.

Remain attentive to the patient during the delivery of therapy. Delay in delivering a shock may result in a rhythm that was identified as shockable converting spontaneously to non-shockable and could result in inappropriate shock delivery.

Keep hands and feet clear of the paddle electrode edges. Use your thumbs to depress the shock buttons on the paddle handles.

Use only pads that are approved for use with the HeartStart XL+. Use of non-approved pads could affect performance and results. See Table 51 for a list of supported pads.

Do not allow multifunction electrode pads to touch each other or to touch other ECG monitoring electrodes, lead wires, dressings, etc. Contact with metal objects may cause electrical arcing and patient skin burns during defibrillation and may divert current away from the heart.

During defibrillation, air pockets between the skin and multifunction electrode pads may cause patient skin burns. To help prevent air pockets, make sure the pads completely adhere to the skin. Do not use dried out pads. Do not open pads package until just prior to use.

Never touch the patient or any equipment connected to the patient (including the bed or gurney) during defibrillation.

Avoid contact between the patient and conductive fluids and/or metal objects such as the gurney.

Medical electrical equipment which does not incorporate defibrillator protection should be disconnected during defibrillation.

CAUTION: Do not discharge the defibrillator with the paddles shorted together.

NOTES: The neonatal patient category is not supported for monitoring. For these patients, use a separate monitor for monitoring.

Successful resuscitation depends on many variables specific to the patient's physiological state and the circumstances surrounding the patient event. Failure to have a successful patient outcome is not a reliable indicator of defibrillator/monitor performance. The presence or absence of muscular response to the transfer of energy during electrical therapy is not a reliable indicator of energy delivery or device performance.

Defibrillation is always performed through paddles or pads. However, during defibrillation you may choose to monitor the ECG using an alternate ECG source (3- or 5-Lead monitoring electrodes). If an alternate ECG source is connected, any available lead may be displayed.

Do not use medical gels or pastes of poor electrical conductivity.

Use only approved lead sets and monitoring electrodes with the HeartStart XL+. Failure to do so may introduce noise and result in intermittent **Cannot Analyze ECG** messages.

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Code View

In Manual Defibrillation Mode, when an energy is selected, Code View is displayed. Code View is optimized to clearly communicate data associated with a resuscitation event (see Figure 49). Code-related information in Code View includes:

Enlarged Wave Sector 1: The waveform in Wave Sector 1 is larger for easier viewing.

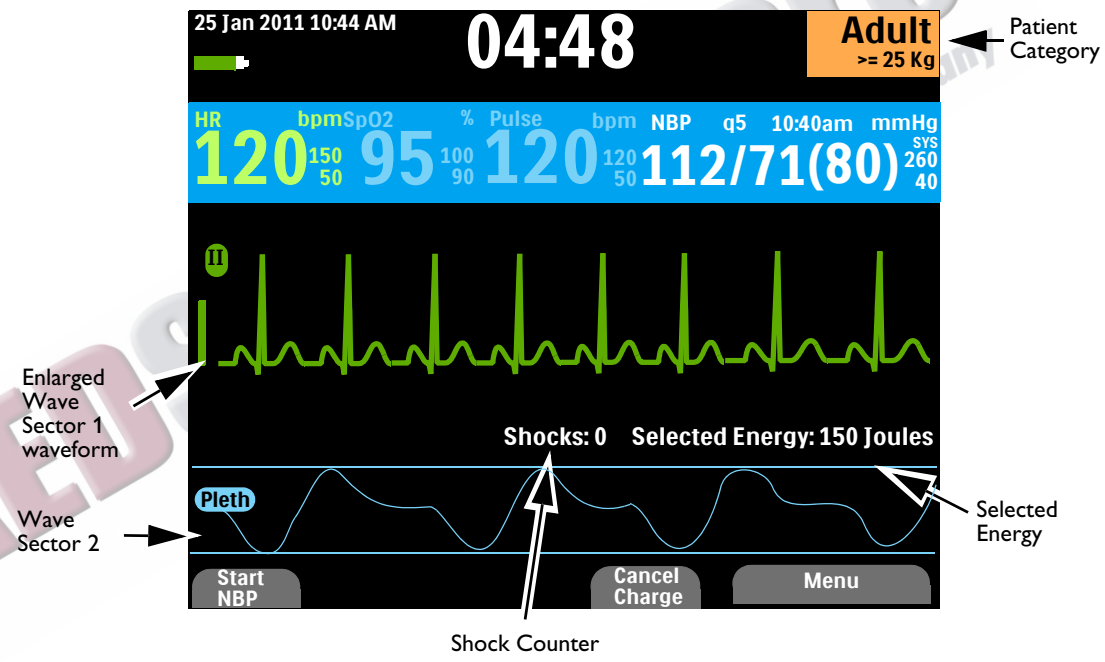
Shock Counter: Displays the number of shocks for the current event (including shocks delivered in AED Mode).

Selected Energy: Displays the currently selected energy.

Wave Sector 2: Displays the currently configured waveform. If Cascade is selected, depending on the ECG size, parts of the wave may be clipped due to the smaller sector size.

Patient Category: Displays the current Patient Category. The patient category triggers specific alarm limits and AED energy settings for defibrillation.

Figure 49 **Code View Layout**



Preparing for Defibrillation

To prepare for defibrillation:

1. Prepare the patient's skin to improve skin contact. See "Skin Preparation" on page 44.
2. Connect the appropriate therapy cable. See "Connecting the Therapy Cable" on page 7.
3. Apply paddles or pads as described in the following sections.

Using Multifunction Electrode Pads

To set up for defibrillating using multifunction electrode pads:

1. Check the expiration date on the pads package and inspect the package for any damage.
2. If not preconnected, connect the Therapy cable to the HeartStart XL+ (see "Connecting the Therapy Cable" on page 7).
3. If the pads are not expired and package is undamaged, open the package and connect the pads connector to the end of the Therapy cable (see "Connecting Multifunctional Pads" on page 8).

NOTE: If you are using Philips' HeartStart Preconnect Pads (989803166021), the pads may already be connected to the end of the Therapy cable. Open the package to apply the pads to the patient.

4. Apply the pads to the patient as directed on the pads packaging or according to your institution's protocol.
5. Follow the defibrillation steps in "Defibrillation" on page 78.

Using External Paddles

To set up for defibrillating using external paddles:

1. After connecting the paddles cable to the HeartStart XL+, remove the paddle set from the paddle tray by pulling the paddles straight up and out of the paddle tray. Confirm you are using the correct size paddles for the patient and verify there is no debris or residue (including dried electrode gel) on the surface of the paddles. Clean if necessary.
2. Apply conductive matter as per your organization's protocol.

CAUTION: Do not distribute conductive matter by rubbing the paddle electrode surfaces together. Surfaces could get scratched or damaged if you do.

3. Apply the paddles to the patient's bare chest using the anterior-anterior placement (or in accordance with your organization's protocol).
4. Use the Patient Contact Indicator (PCI) lights on the sternum paddle handle to adjust paddle pressure and placement to optimize patient contact. Once proper contact is made, the PCI turns green. See "External Paddles" on page 11.

NOTE: Reasonable effort should be made to obtain at least one green PCI light. Due to size of the patient or other physical factors, this might not be possible for some patients. Orange lights may be the best that can be achieved.

5. Follow the defibrillation steps in "Defibrillation" on page 78.

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Quick Look

You can use external paddles for a "Quick Look" to assess the patient's ECG rhythm and then, if necessary deliver therapy. Use this process only when multifunction pads and monitoring electrodes are not immediately available.

To view a patient's ECG using external paddles:

1. Make sure the device is turned on to **Monitor**.
2. Apply external paddles to the patient's chest, minimizing any unnecessary movement.
3. After the HeartStart XL+ detects the ECG, view the waveform on the display.

NOTE: Viewing the patient's ECG through paddles is not recommended for long-term monitoring.

Using Infant Paddles

The HeartStart XL+ external paddle set comes with infant paddles included. The American Heart Association recommends using the smaller paddles on children weighing less than 10 kg. Larger paddles may be used as long as contact between the paddles is avoided.

To set up for defibrillating using infant paddles:

1. Expose the infant paddle surfaces, see "Accessing Infant Paddles" on page 12.
2. Store the adult paddle surfaces in the paddle tray pockets.
3. Follow the steps for using external paddles, see "Using External Paddles" on page 76.
4. Follow the defibrillation steps in "Defibrillation" on page 78.

Using Internal Paddles

To set up for defibrillating using internal paddles:

1. Select the appropriate paddle electrode size.
2. If using switchless internal paddles, connect the paddles to the M4740A Paddle Adapter Cable.
3. Connect the paddles cable (or the paddle adapter cable) to the HeartStart XL+. See "Connecting the Therapy Cable" on page 7.
4. Follow the defibrillation steps in "Defibrillation" on page 78.

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Defibrillation

After performing the necessary preparation, defibrillation with HeartStart XL+ is a simple 1-2-3 process.

1 Select an energy.

2 Charge the device.

3 Administer the shock.

See the following sections for more information.

Step 1 - Select Energy

Rotate the Therapy knob to the desired energy level. The current energy selection is displayed on the device in the Select Energy section. The recommended energy dose for adult patients is 150J. Follow your institution's guidelines for Infant/Child patients.

Energy choices range from 1 to 200J with 150J highlighted as the recommended level for adult patients. Selecting the **1-10** energy setting brings up the Select Energy menu. See Figure 50. Use the Navigation buttons to increase or decrease the desired setting. The HeartStart XL+ automatically knows your energy setting.

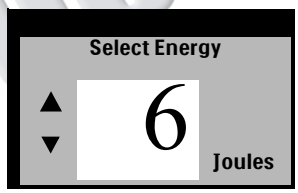
To re-adjust a low energy setting:

1 Press the Menu Select button.

2 Use the Navigation buttons to select **Energy 1-10 Joules** and press the Menu Select button.

3 Use the Navigation buttons to increase or decrease the energy level and press the Menu Select button.

Figure 50 **Select Energy**



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WARNINGS: For manual defibrillation of infant/child patients follow your institution's policy (guidelines are 2 to 4 J/kg first shock and 4 J/kg per subsequent shocks).

The HeartStart XL+ has a built-in limitation of 50 Joules when using internal paddles.

Do not leave patients unattended when the HeartStart XL+ is in Manual Defibrillation Mode with pads applied to the patient.

Step 2 - Charge

Press the Charge button on the front panel. See "Therapy Knob and Controls" on page 22. If using external paddles, the charge button on the side of the apex paddle may be used instead. As the defibrillator charges, the energy selection shown on the display changes to show the current charge state. A continuous low-pitch charging tone sounds until the desired energy level is reached at which point a continuous high-pitch charged tone sounds.

You may increase or decrease the selected energy at any time during or after charging. Move the Therapy knob to the desired energy level. The HeartStart XL+ charges to the selected energy level automatically.

If you need to disarm the defibrillator, press the **[Cancel Charge]** soft key. Also, the defibrillator disarms automatically when the Shock button has not been pressed within the time period specified in the Time to Auto Disarm configuration setting.

Step 3 - Shock

Confirm that a shock is still indicated and the defibrillator is charged to the selected energy level. Make sure no one is touching the patient or anything connected to the patient. Call out loudly and clearly, "Stay Clear!"

If using:

- **Pads or switchless internal paddles** - Press the flashing Shock button on the front of the HeartStart XL+ to deliver a shock.
- **External paddles** - Simultaneously press the flashing Shock buttons located on the paddles to deliver a shock.
- **Switched internal paddles** - Press the orange Shock button located on the paddle to deliver a shock.

WARNINGS: Defibrillation current can cause operator or bystander injury. Do not touch the patient, or equipment connected to the patient, during defibrillation.

Alarm audio is turned off when an energy setting is selected for defibrillation, and the **Alarm Audio Off** message is displayed. Audio remains off until turned back on by pressing the Alarm button, Sync Mode is turned on or the Therapy knob is turned to **Monitor** or **Pacer**.

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Manual Defibrillation Alarms

Defibrillation alarms can be generated for the conditions shown in Table 18. There are both audio and visual alerts when activated by the Alarms button. When you switch patient categories, all parameter alarm limits change to the new patient category. These changes are retained when you switch modes.

- For patients that are ≥ 25kg or ≥ 8 years old, use Adult patient category.
- For patients <25kg or < 8 years old, use Infant/Child patient category.

For more information on alarms, see "Alarms" on page 33.

Table 18 **Defibrillation Alarms**

Alarm Message	Condition	Type of Alarm	Indication
Pads Off	With pads in use, the connection between the device and patient has been lost.	High Priority Non-Latching Alarm	Red Alarm message with alarm tone
Shock Aborted	A shock has been automatically aborted.	High Priority Latching Alarm	
Abnormal Shock Dose Delivered	Abnormal shock dose delivered due to marginal patient impedance.		
Pads/Paddle Type Unknown	The device detected a change in paddles or pads type or the therapy cable identification is invalid.		
Equipment Disabled: Therapy	Therapy is disabled due to an equipment failure.		
Paddles Power Overload	A power overload has been detected in the paddles.	Medium Priority Latching Alarm	Yellow Alarm message with alarm tone

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Troubleshooting

If your HeartStart XL+ does not operate as expected during Manual Defibrillation, see Table 46 "Defibrillation and Pacing Problems" on page 180.

If there is a delay in delivering therapy, start CPR if indicated.

7

Cardioversion

This chapter explains how to prepare for and perform synchronous cardioversion on the HeartStart XL+.

See Chapter 6 “Manual Defibrillation” on page 73 for information on asynchronized cardioversion.

Overview

The HeartStart XL+ provides synchronized cardioversion therapy by delivering a biphasic pulse of current to the heart immediately following an R-Wave detected in the ECG waveform. The waveform utilized in the HeartStart XL+ has undergone clinical testing demonstrating its effectiveness for cardioversion of atrial fibrillation.

You can perform synchronized cardioversion with:

- Multifunction electrode pads or external paddles and 3 or 5-Lead set monitoring electrodes directly connected to the HeartStart XL+.
- Only the multifunction electrode pads directly connected to the HeartStart XL+.
- Multifunction electrode pads directly connected to the HeartStart XL+ and an ECG signal coming from a Philips bedside monitor into the HeartStart XL+.

NOTE: The best quality source for cardioversion is a 3 or 5-Lead set connected to the HeartStart XL+.

No matter what your monitoring source is, cardioversion is still delivered through pads or paddles.

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Precautions for Cardioversion

WARNINGS: Cardioversion should only be delivered by trained healthcare professionals.

When performing synchronized cardioversion through external paddles, you should not use paddles as your monitoring lead in Wave Sector 1. Artifact introduced by paddle movement may resemble an R-Wave arrow and trigger a defibrillation shock. Use external paddles as a monitoring lead for Synchronized Cardioversion only if no other lead source is available and you are in an emergency situation.

Incorrect timing of Synchronized Cardioversion could occur if the patient has an internal pacemaker with pacemaker tails large enough to be detected as an R-Wave.

Use only pads that are approved for use with the HeartStart XL+. Use of non-approved pads could affect performance and results. See Table 51 for a list of supported pads.

Remain attentive to the patient during the delivery of therapy.

Keep hands and feet clear of the paddle electrode edges. Use your thumbs to depress the shock buttons on the paddle handles.

Do not allow multifunction electrode pads to touch each other or to touch other ECG monitoring electrodes, lead wires, dressings, etc. Contact with metal objects may cause electrical arcing and patient skin burns during defibrillation and may divert current away from the heart.

During defibrillation, air pockets between the skin and multifunction electrode pads may cause patient skin burns. To help prevent air pockets, make sure the pads completely adhere to the skin. Do not use dried out pads. Do not open pads package until just prior to use.

Never touch the patient or any equipment connected to the patient (including the bed or gurney) during defibrillation.

Avoid contact between the patient and conductive fluids and/or metal objects such as the gurney.

Medical electrical equipment which does not incorporate defibrillator protection should be disconnected during defibrillation.

NOTES: Successful cardioversion depends on many variables specific to the patient's physiological state and the circumstances surrounding the patient event. Failure to have a successful patient outcome is not a reliable indicator of defibrillator/monitor performance. The presence or absence of muscular response to the transfer of energy during electrical therapy is not a reliable indicator of energy delivery or device performance.

The neonatal patient category is not supported for Cardioversion.

Synchronized Cardioversion should be turned off unless you specifically intend to perform synchronized cardioversion. Sync Mode can prevent the delivery of defibrillation in situations involving cardiac arrest.

If you enter Pacing Mode, Sync settings are turned off.

Use only approved lead sets with the HeartStart XL+. Failure to do so may introduce noise and result in intermittent **Cannot Analyze ECG** messages.

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Preparing for Synchronized Cardioversion

To prepare for synchronized cardioversion:

1. Perform tasks as described in "Preparing for Defibrillation" on page 76.
2. If monitoring through a 3- or 5-Lead ECG cable, plug the ECG cable into the ECG port on the HeartStart XL+ and apply monitoring electrodes to the patient (see "Lead Selection" on page 47).
3. Use the Lead Select button to select the waveform you want in Wave Sector 1. The selected ECG source should have a clear signal and a large QRS complex. Use external paddles as the monitoring lead only if no other lead source is available. See "With External Paddles" on page 85.

NOTES: When a patient is already connected to Philips bedside monitoring equipment, an external "Sync" cable can plug into the bedside's ECG Output jack and into the HeartStart XL+'s ECG port. This connects the ECG signal from the monitor into the HeartStart XL+ where it is displayed and synchronization occurs.

The signal from the bedside monitor is displayed as Lead II on the HeartStart XL+ even though it may not necessarily be Lead II coming from the bedside monitor.

Do not use a Philips SureSigns monitor connected to the HeartStart XL+. The devices are not compatible.

WARNING: If you use an external monitor as the ECG source, a biomedical technician MUST verify that the combination of the external monitor and HeartStart XL+ can deliver a synchronized shock within 60ms of the peak of the R-Wave. Use a 1 mV QRS complex with a QRS width of 40 ms. This performance cannot be guaranteed with all commercially available monitors.

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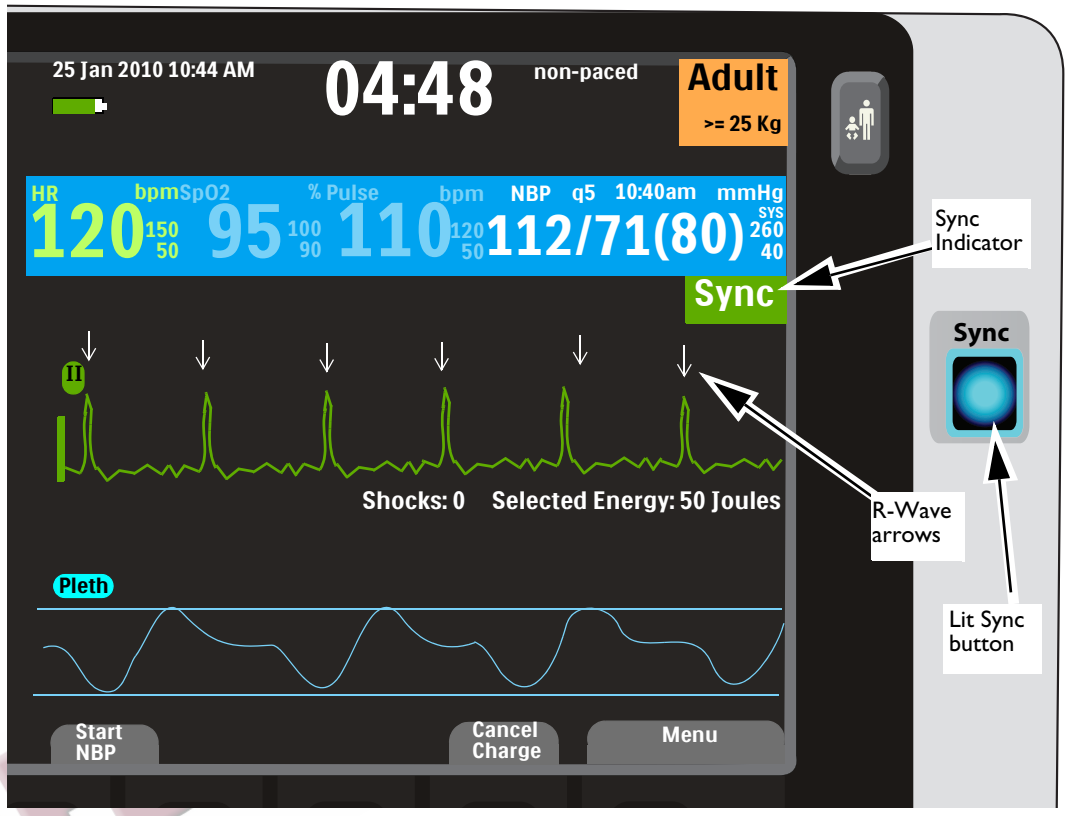
Code View and Cardioversion

When Synchronized Cardioversion is active, Code View adds R-Wave arrows and a Sync notification to the display. The Sync button is also backlit. See Figure 51.

Figure 51 **Code View With Sync Layout**



Delivering a Synchronized Shock

To perform synchronized cardioversion:

1. Turn the Therapy knob to the desired energy setting
2. Press the Sync button (see Figure 1 on page 6).
3. Confirm that the Sync button lights up, the Sync indicator is present and R-Wave arrows appear only with each R-Wave.

   R-Wave arrows do not always appear at the peak of the R-Wave but always appear on the R-Wave. Use the Lead Select button to change leads if the R-Wave arrows do not appear correctly.
4. Press the yellow Charge button on the HeartStart XL+, or if using paddles, the yellow charge button located on the apex paddle.

   You may increase or decrease the selected energy at any time during charging or after charging. Move the Therapy knob to the desired energy level. The HeartStart XL+ charges to the selected energy level automatically. Wait until the charge reaches the selected energy level before proceeding.

   If you need to disarm the defibrillator, press the **[Cancel Charge]** soft key. Also the defibrillator disarms automatically when the Shock button has not been pressed within the time period specified in the Time to Auto Disarm configuration setting.
5. When the defibrillator has reached its charge level, make sure no one is touching the patient or anything connected to the patient. Call out clearly and loudly "Stay Clear".
6. Check your ECG and then re-confirm your energy dose and waveform. Press and hold the Shock button on the HeartStart XL+ or, if using external paddles, press and hold the orange buttons on both paddles. It is important to continue to hold the Shock button (or the paddle buttons) until the shock is delivered. The defibrillator shocks with the next detected R-Wave. Once the shock is delivered, release the shock button. The Shock counter increases by one.

WARNINGS: Defibrillation current can cause operator or bystander injury. Do not touch the patient, or equipment connected to the patient, during defibrillation.

Do not change the energy level while holding the Shock button down.

NOTE: If an ECG or pads technical alarm occurs while performing synchronized cardioversion, the HeartStart XL+ does not charge, and if charged, disarms automatically.

With External Paddles

Carefully review the waveform immediately prior to administering synchronized cardioversion and confirm that you have a non-paddles wave label.

WARNING: When performing synchronized cardioversion through external paddles, you should not use paddles as your monitoring lead in Wave Sector 1. Artifact introduced by paddle movement may resemble an R-Wave arrow and trigger a defibrillation shock. Use external paddles as a monitoring lead for Synchronized Cardioversion only if no other lead source is available and you are in an emergency situation.

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To perform synchronized cardioversion using external paddles:

1. Prepare your patient for synchronized cardioversion as stated above.
2. Place paddles on the patient's chest prior to charging the defibrillator.
3. Look at the wave label appearing in Wave Sector 1.

   If the label is Paddles:

   - Change the monitoring lead in Wave Sector 1 by pressing the Lead Select button multiple times to cycle through available leads. Select the waveform you wish to use.
   - Confirm a non-paddles monitoring leads appears in Wave Sector 1. Check for R-Wave arrows.
   - Proceed with the normal protocol for synchronized cardioversion.

   If the label is not Paddles:

   - Proceed with the normal protocol for synchronized cardioversion.

Delivering Additional Shocks

There are times when additional synchronized shocks are clinically indicated.

To deliver additional synchronized shocks:

1. Confirm the Sync function is still enabled, the Sync button is lit, the Sync indicator is present and the R-Wave arrows are still visible.
2. Repeat steps 3-5 under "Delivering a Synchronized Shock" on page 85.

NOTE: The HeartStart XL+'s Sync function can be configured to either be enabled or disabled after each synchronized shock is delivered.

Turning Sync Off

To turn the Sync function off, press the Sync button again. The button light turns off and Sync indications are removed from the display.

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Cardioversion Alarms

Alarms can be generated for the conditions shown in Table 19. There are both audio and visual alerts. When you switch patient categories, all parameter alarm limits change to the new patient category. These changes are retained when you switch modes.

- For patients that are ≥ 25kg or ≥ 8 years old, use Adult patient category.
- For patients <25kg or < 8 years old, use Infant/Child patient category.

For more information on alarms, see "Alarms" on page 33.

Table 19 **Defibrillation Alarms**

Alarm Message	Condition	Type of Alarm	Indication
Pads Off	With pads in use, the connection between the device and patient has been lost.	High Priority Non-Latching Alarm	Red Alarm message with alarm tone
Shock Aborted	A shock has been automatically aborted.	High Priority Latching Alarm	
Abnormal Shock Dose Delivered	Abnormal shock dose delivered due to marginal patient impedance.		
Pads/Paddle Type Unknown	The device detected a change in paddles or pads type or the therapy cable identification is invalid.		
Equipment Disabled: Therapy	Therapy is disabled due to an equipment failure.		

Troubleshooting

If your HeartStart XL+ does not operate as expected during Cardioversion, see Table 46 "Defibrillation and Pacing Problems" on page 180.

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NOTES

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Pacing

This chapter explains the noninvasive transcutaneous pacing option available with the HeartStart XL+ and describes how to perform pacing.

Overview

Noninvasive transcutaneous pacing therapy is used to deliver monophasic pace pulses to the heart. Pace pulses are delivered through multifunction electrode pads that are applied to the patient's bare chest. Pacing with paddles is not supported.

While in Pacing Mode, the ECG strip and Event Summary are easily annotated using the Mark Event button. See "Mark Events" on page 134.

The HeartStart XL+ Pacing Mode can be used on both adult and infant/child patients. Use the Patient Category button to switch categories.

WARNING: Pacing therapy should only be delivered by trained healthcare professionals.

CAUTION: Pacing must be turned off before defibrillating with a second defibrillator. Failure to do so could damage the HeartStart XL+.

NOTES: Use only approved lead sets when pacing with the HeartStart XL+. Failure to do so may introduce noise and result in intermittent **Cannot Analyze ECG** messages.

For treatment of patients with implantable devices, such as permanent pacemarkers or cardioverter-defibrillators, consult a physician and the instructions for use provided by the device's manufacturer.

The neonatal patient category is not supported for Demand Mode pacing.

Waveforms, ECG monitoring, measurements and most alarms remain active and retain their settings when you transition from Monitor or Manual Defibrillation Mode to Pacing Mode. However, the waveform displayed in Wave Sector 3 is replaced by the Pacing Status Bar.

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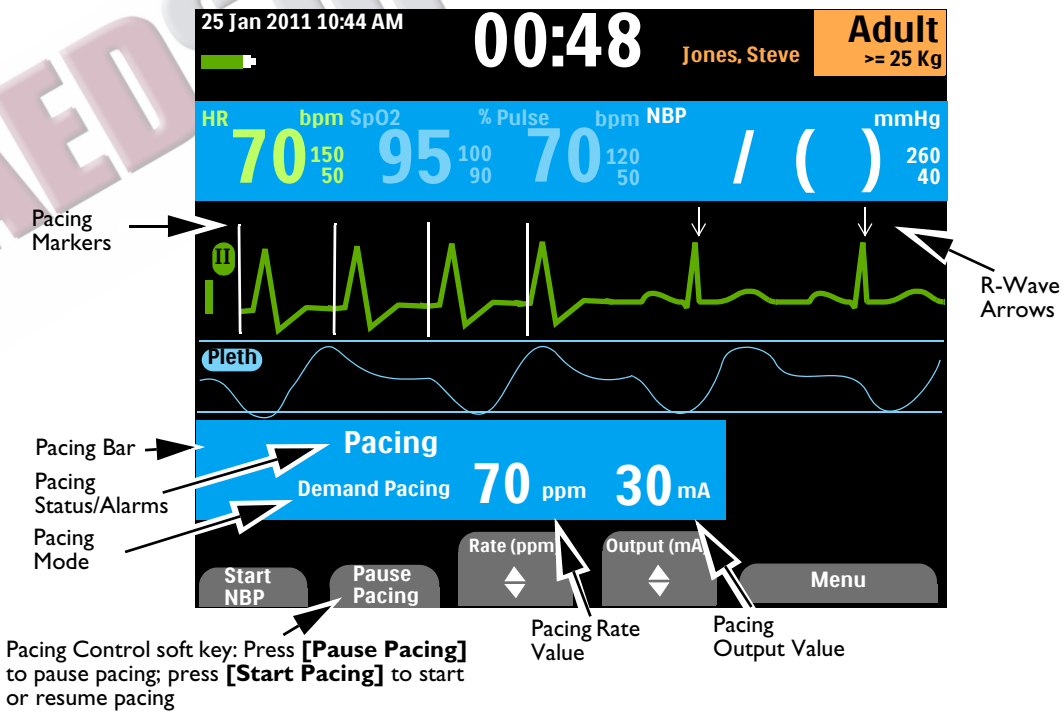
Pacing View

Pacing View appears when the Therapy knob is turned to the **Pacer** position. Pacing View includes a status block which appears in Wave Sector 3 of the display (see Figure 52). Pacing-related information in Pacing View includes:

- **Pacing Markers:** Markers, indicating a pace pulse was delivered, appear in Wave Sector 1 (and in Wave Sector 2, if the wave is cascading) each time a pacer pulse is delivered.
- **R-Wave Arrows:** R-Wave arrows appear in Wave Sector 1 (and in Wave Sector 2, if the wave is cascading) when in Demand Mode pacing. R-Wave arrows do not appear on paced beats.
- **Pacing Status:** Indicates the current pacing status.
  - When pacing is active, **Pacing** is displayed when the device is on AC power.
  - If the device is running on battery, **Pacing on Battery** is displayed.
  - If pacing is not active, **Pacing Paused** is displayed.
- **Pacing Alarm:** If there is a pacing-related alarm during pacing, the current pacing status is replaced with an alarm message. See "Pacing Alarms" on page 97.
- **Pacing Mode:** Indicates if the device is in Demand or Fixed Mode Pacing.
- **Pacing Rate:** Indicates the current pacing rate, including unit of measure.
- **Pacing Output:** Indicates the current output, including unit of measure.
- **Start/Pause Pacing soft key:** Starts or pauses pacing.
- **Alarms:** Are on automatically.

Figure 52 **Pacing View Layout**



WARNING: If pacing is interrupted for any reason, you must press the **[Start Pacing]** soft key to resume pacing.

Demand Mode Versus Fixed Mode

The HeartStart XL+ can deliver paced pulses in either Demand Mode or Fixed Mode.

- In Demand Mode, the pacer only delivers synchronous paced pulses when the patient's heart rate is lower than the selected pacing rate.
- In Fixed Mode, the pacer delivers asynchronous paced pulses at the selected rate.

WARNING: Use Demand Mode pacing whenever possible. Use Fixed Mode pacing when artifact or other ECG noise makes R-Wave detection unreliable, when monitoring electrodes are not available or at your clinical discretion.

The HeartStart XL+ requires a 3- or 5-Lead ECG cable and monitoring electrodes as the source of the ECG during Demand Mode pacing. Pace pulses are delivered through multifunction electrode pads. However, during Demand Mode pacing, the pads cannot be used to monitor ECG and deliver paced pulses simultaneously.

NOTES: The ECG derived from pads does not need to be displayed in a wave sector in order to deliver pacing therapy.

When using the HeartStart XL+ for pacing in the Operating Room in the presence of cautery tools, use Fixed Mode only.

When using Demand Mode, pads are not an available choice for display in Wave Sector 1, through either the Lead Select button or the Displayed Waves menu.

Preparing for Pacing

To prepare for pacing:

1. If not already connected, connect the Therapy cable to the HeartStart XL+. See "Connecting the Therapy Cable" on page 7.
2. Prepare the patient's skin to achieve good contact. See "Skin Preparation" on page 44.
3. Connect the multifunction electrode pads. See "Connecting Multifunction Electrode Pads" on page 8.
4. If pacing in Demand Mode, apply monitoring electrodes (see "Electrode Placement" on page 45) and connect the ECG cable to the HeartStart XL+ (see "Connecting the ECG cable" on page 9).

WARNING: Do not reverse pad position on the patient. Reversing the pads' positions increases the pacing threshold which means more current is needed to capture the heart, resulting in greater patient discomfort.

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NOTES: Pacing Therapy should be administered while connected to AC power with a battery installed for backup so that pacing will not be interrupted in the event of either an AC power failure or the battery losing its charge.

If you enter Pacing Mode, Sync settings are turned off.

If Paddles is selected for display in Wave Sector 2 and the device enters Pacer Mode, the Wave Sector 2 waveform automatically switches to None.

If Pads is selected for the display in Wave Sector 2 and the device enters Demand Mode pacing, the Wave Sector 2 waveform automatically switches to None.

If monitoring for an extended period of time, monitoring electrodes and multifunction electrode pads may need to be changed periodically. Refer to the manufacturer's documentation for replacement frequency.

Signals from TENS or ESU units can cause interference with the ECG which may impact pacing.

Pace Pulse Duration

You can configure the duration of the paced pulse in Configuration Mode to either 20 or 40 msec. Confirm with your organization which setting best meets your clinical needs. If you select 20 msec, you can select a current setting between 10-200 mA. If you select 40 msec, you can select a current setting between 10-140 mA. See "Pacer Settings" on page 144.

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Demand Mode Pacing

To pace in Demand Mode:

1 Turn the Therapy knob to the **Pacer** position.

The message **Pacing Paused** appears in the Pacing Bar indicating the pacing function is enabled but pace pulses are not being delivered. Pacing is enabled in Demand Mode with the configured lead in Wave Sector 1 used for R-Wave detection.

NOTES: If the configured lead is Pads, Lead II or the first available monitoring lead is displayed automatically.

While in Demand Mode pacing, if you change the lead in Wave Sector 1, the HeartStart XL+ waits a second before notifying you with a Cannot Analyze ECG alarm.

2 Press the Lead Select button to select the best lead with an easily detectable R-Wave. (See "Lead Selection" on page 47).

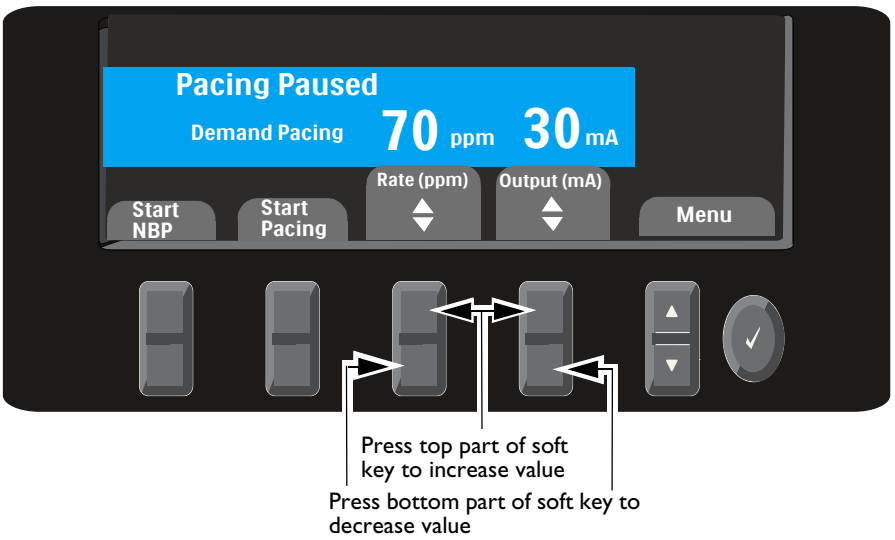
3 Verify white R-Wave arrows appear above or on the ECG waveform. A single arrow should be associated with each R-Wave. If the R-Wave arrows do not appear, are incorrectly labeling beats or do not coincide with the R-Wave, select another lead.

NOTE: If you are using anterior-anterior pad placement while pacing and are experiencing difficulty with Lead II, select another lead.

4 Select the pacer rate by pressing the **[Rate]** soft key. Use the upper portion of the soft key to increase the rate and the lower portion of the soft key to decrease the rate. See Figure 53.

5 If needed, adjust the initial pacer output. Press the **[Output]** soft key. Use the upper portion of the soft key to increase the output and the lower portion of the soft key to decrease the output. See Figure 53.

Figure 53 **Pacer Keys**



6 Press **[Start Pacing]** **Pacing** appears in the Pacing Bar.

7 Verify white pacing markers or white R-Wave arrows appear on the ECG waveform.

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8 Press the **[Output]** soft key.

a Use the upper portion of the soft key to increase the output until cardiac capture occurs. Capture is indicated by the appearance of a QRS complex after each pacing marker.

b Use the lower portion of the soft key to decrease the output to the lowest level that still maintains capture.

9 Assess the patient for a peripheral pulse. (Pulse alarms are automatically turned on.)

To stop pacing:

- Press the **[Pause Pacing]** soft key. A prompt message asks you to confirm your action. Using the Navigation buttons, select **Yes** to pause pacing; select **No** to continue pacing. Once paused, press the flashing **[Start Pacing]** soft key to resume pacing.

  OR

- Move the Therapy knob away from the **Pacer** position.

WARNINGS: Use care when handling the multifunction electrode pads on the patient to avoid shock hazard during pacing.

Use multifunction electrode pads prior to their expiration date. Discard pads after use. Do not reuse pads. Do not use for more than 8 hours of continuous pacing.

If pacing is interrupted for any reason you must press the **[Start Pacing]** soft key to resume pacing.

When pacing in Demand Mode, the ECG cable from the patient must be directly connected to the HeartStart XL+.

If you are using the pacing function with battery and the Low Battery alarm sounds, connect the device to external power to avoid interrupted pacing therapy.

NOTES: Pacing does not start if there is a problem with the multifunction electrode pads connection or patient contact. Pace pulses are not delivered if there is a problem with the ECG monitoring electrode connections. If either situation occurs, a system message is displayed.

The **[Start Pacing]** soft key is grayed out for Demand Mode pacing until a leads-on condition is detected for the ECG lead used for R-Wave detection and the pads on condition is detected. In Fixed Mode, the soft ley is grayed out until pads are detected.

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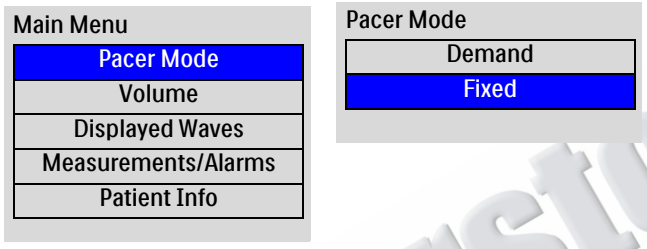
Fixed Mode Pacing

To pace in Fixed Mode:

1. Turn the Therapy knob to the **Pacer** position.
   The message **Pacing Paused** appears in the Pacing Bar and indicates the pacing function is enabled but pace pulses are not being delivered. Demand pacing is the default pacer mode.
2. Change to Fixed Mode pacing.
   a. Press the Menu Select button.
   b. Using the Navigation buttons, select **Pacer Mode** and press the Menu Select button.
   c. Select **Fixed** and press the Menu Select button. (See Figure 54.)

Figure 54 **Changing Pacing Modes**



3. Use the Lead Select button to select the desired lead for viewing, if one is available.

NOTE: If you want to see the ECG waveform and related parameters while pacing, you must have ECG electrodes on the patient with pads. Viewing Pads in Wave Sector 1 while pacing may give you an incorrect heart rate and inappropriate alarms.

4. Select the pacer rate by pressing the **[Rate]** soft key. Use the upper portion of the soft key to increase the rate and the lower portion of the soft key to decrease the rate.
5. If needed, adjust the initial pacer output. Press the **[Output]** soft key. Use the upper portion of the soft key to increase the output and the lower portion of the soft key to decrease the output.
6. Press **[Start Pacing]**. **Pacing** appears in the Pacing Bar.
7. If you have an ECG waveform, verify white pacing markers appear.
8. Verify the presence of a peripheral pulse and increase output if required.
9. Press the **[Output]** soft key.
   a. Use the upper portion of the soft key to increase the output until cardiac capture occurs. If the ECG is on the display, capture is indicated by the appearance of a QRS complex after each pacing marker.
   b. Use the lower portion of the soft key to decrease the output to the lowest level that still maintains capture.
10. Assess the patient for a peripheral pulse. (Pulse alarms are automatically turned on.)

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To stop pacing:

- Press the **[Pause Pacing]** soft key. A prompt message asks you to confirm your action. Using the Navigation buttons, select **Yes** to pause pacing; select **No** to continue pacing. Once paused, press the flashing **[Start Pacing]** soft key to resume pacing.

  OR

- Move the Therapy knob away from the **Pacer** position.

WARNINGS: Use care when handling the multifunction electrode pads on the patient to avoid shock hazard during pacing.

Use multifunction electrode pads prior to their expiration date. Discard pads after use. Do not reuse pads. Do not use for more than 8 hours of continuous pacing.

If pacing is interrupted for any reason you must press the **[Start Pacing]** soft key to resume pacing.

If you are using the pacing function with battery and the Low Battery alarm sounds, connect the device to external power to avoid interrupted pacing therapy.

Defibrillating During Pacing

If you need to defibrillate the patient during pacing, refer to the procedure for defibrillation in Manual Defibrillation Mode (see Chapter 6 “Manual Defibrillation” on page 73) or AED Mode (Chapter 5 “AED Mode” on page 59). Once the Therapy knob is moved from the **Pacer** position to a Manual Defibrillation Mode energy setting or **AED**, pacing is stopped.

To resume pacing after defibrillation, repeat the pacing procedure as described in “Demand Mode Pacing” on page 93 or “Fixed Mode Pacing” on page 95. When pacing is resumed, pacing settings selected prior to defibrillation (mode, rate and output) are retained. Be sure to confirm cardiac capture has been retained.

CAUTION: Pacing must be turned off before defibrillating with a second defibrillator. Failure to do so could damage the HeartStart XL+.

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Pacing Alarms

Pacing alarms can be generated for the conditions shown in Table 20. Once generated, they appear as alarm messages in the Pacer Bar. There are both audio and visual alerts. When you switch patient categories, all parameter alarm limits change to the new patient category. These changes are retained when you switch modes.

- For patients that are ≥ 25kg or ≥ 8 years old, use Adult patient category.
- For patients <25kg or < 8 years old, use Infant/Child patient category.

For more information on alarms, see "Alarms" on page 33.

Table 20 **Pacing Alarms**

Alarm Message	Condition	Type of Alarm	Indication
Pacing Stopped. Power Interrupted.	Pacing has stopped. There has been a power failure during pacing.	High Priority Non-Latching Alarm	Red Alarm message with alarm tone
Pacing Stopped. Pads Off.	Pacing has stopped. A pads off condition has been detected during pacing.		
Pacing Stopped. Device Error.	Pacing has stopped. The HeartStart XL+ has detected an error which prevents delivery of pacing therapy.		
Pacing Stopped. Pads Cable Off.	Pacing has stopped. The Therapy cable is disconnected from the device.		
Equipment Disabled: Therapy	Therapy is disabled due to an equipment failure.		
Pacing Stopped. Leads Off.	Pacing has stopped. The primary ECG lead has become invalid in Demand Mode pacing.		
Pacer Output Low	The actual delivered pace pulse current is less than the selected output.		
Battery Low	The battery's charge level is low.		

NOTE: Once the reason for the Pacing Stopped alarm has been resolved, that part of the alarm message is removed from the display. The audio alarm continues. You must press the **[Start Pacing]** soft key to resume pacing, remove the remainder of the alarm from the display and silence the audio alarm.

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WARNING: Observe the patient closely while pacing. Heart rate displays and alarms function during pacing but can be unreliable. Do not rely on the indicated heart rate or heart rate alarms as a measure of the patient's perfusion status.

Troubleshooting

If your HeartStart XL+ does not operate as expected during pacing, see "Defibrillation and Pacing Problems" on page 180.

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Pulse Oximetry

Pulse Oximetry (SpO_2) is one of the tools available to assist in assessing a patient's cardiac and respiratory systems. This chapter explains how Pulse Oximetry works and how to use the HeartStart XL+ to monitor SpO_2.

Overview

Pulse oximetry is a non-invasive method of continuously measuring functional oxygen saturation (SpO_2) in arterial blood. SpO_2 readings indicate the percentage of hemoglobin molecules in arterial blood which are saturated with oxygen.

You can monitor SpO_2 in all HeartStart XL+ clinical modes and on both adult and infant/child patients. Use the Patient Category button to switch categories.

When pressing the Patient Category button, all parameter alarm limits change to the new patient category. These changes are retained when you switch modes.

- For patients that are ≥ 25kg or ≥ 8 years old, use Adult patient category
- For patients <25kg or < 8 years old, use Infant/Child patient category
  The neonatal patient category is not supported.

WARNINGS: Do not leave an SpO_2 sensor on a patient undergoing an MRI.

For patients with an intra-aortic balloon pump, access peripheral pulses according to your institution's protocol.

Do not rely solely on SpO_2 readings; assess the patient at all times. Inaccurate measurements may be caused by:

- Incorrect sensor application or use
- Significant levels of intravascular dyshemoglobins such as carboxyhemoglobin or methemoglobin in patient
- Patients with other disorders of hemoglobin
- Patients with restricted blood flow to the extremities (such as those in severe shock or hypothermia)
- Injected dyes such as methylene blue
- Exposure to excessive illumination such as surgical lamps (especially those with a xenon light source), bilirubin lamps, fluorescent lights, infrared heating lamps or direct sunlight

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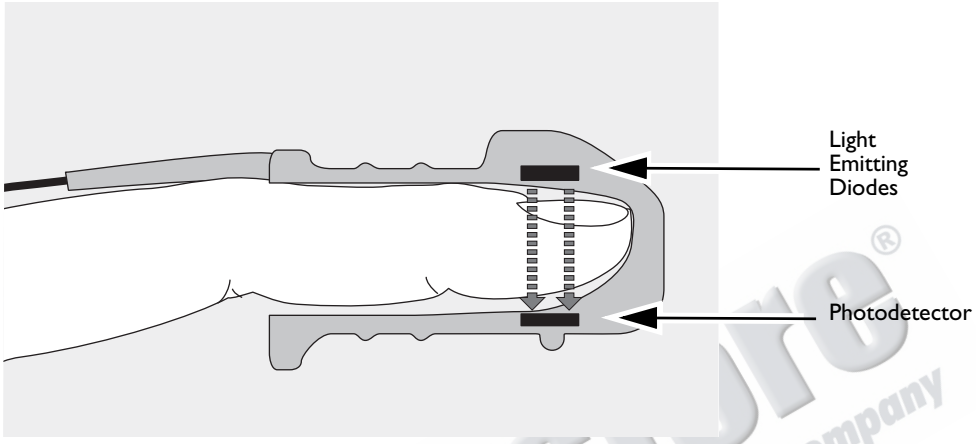
Understanding Pulse Oximetry

A pulse oximetry sensor sends light through patient tissue to a receiver on the other side of the sensor. Light-emitting diodes transmit red and infrared light through the peripheral areas of the body such as a finger. See Figure 55.

Figure 55 **Pulse Oximetry Sensor**



A photodetector positioned opposite the light emitting diodes compares the light absorbtion before and after pulsation. The amount of light getting through reflects the blood flow in the aterioles. This measurement of light absorbtion during pulsation is translated into an oxygen saturation percentage. The SpO_2 value and wave are displayed.

WARNING: SpO_2 readings can be inaccurate in patients that:

- Are hypothermic
- Are acidotic
- Are receiving a photosensitive drug
- Are receiving vasoconstrictor medications
- Have poor circulation

NOTE: For accurate SpO_2 measurements, the following conditions must apply:

- The patient must have perfusion in that extremity.
- The light emitter and photodetector must be directly opposite each other.
- All of the light from the emitter must pass through the patient's tissue.
- The sensor site should be free of vibration and excessive motion.
- The sensor cable and connector should be positioned away from power cables to avoid electrical interference.

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Selecting a Sensor

The most important factor when selecting a sensor is the position of the light emitting diodes in relation to the photodetector. When the sensor is applied, the diodes and the photodetector must be opposite each other. Sensors are designed for patients with a specific weight range and for specific sites. Be sure to:

- Select a sensor appropriate for the patient's weight.
- Select a sensor site with adequate perfusion.
- Improve perfusion at the site by rubbing or warming the site.
- Avoid application to sites with edematous tissue.

SpO_2 sensors are either reusable or disposable. Reusable sensors can be reused on different patients after they have been cleaned and disinfected (see the manufacturer's instructions supplied with the sensor). Disposable sensors should only be used once and then discarded. They may be relocated to another appropriate site on the same patient but not reused on different patients.

See "SpO_2 Sensors and Cables" on page 193 for a list of SpO_2 sensors and accessories that can be used with the HeartStart XL+.

CAUTIONS: Do not use disposable sensors in high humidity environments or in the presence of fluids which may contaminate sensor and electrical connections, causing unreliable or intermittent measurements.

Do not use disposable sensors on patients who have allergic reactions to adhesive.

Do not use more than one extension cable (M1941A).

Do not use the ear transducer on patients with small ear lobes as incorrect measurements may result.

Applying the Sensor

Follow the manufacturer's directions for applying and using the sensor, making sure to observe any warnings or cautions. For best results:

- Make sure the sensor is dry.
- If the patient is moving, secure the sensor cable loosely to the patient.
- Make sure the sensor is not too tight. Too much pressure can cause venous pulsation or can impede blood flow, resulting in low readings.
- Keep power cables away from the sensor cable and connection.
- Avoid placing the sensor in an environment with bright lights. If necessary, cover the sensor with opaque material.
- Avoid placing the sensor on an extremity with an arterial catheter, blood pressure cuff or intravenous infusion line.

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WARNINGS: Failure to apply the sensor properly may reduce the accuracy of the SpO_2 measurement.

Inspect the sensor application site at least every two hours for changes in skin quality, correct optical alignment and proper sensor application. If skin quality is compromised, change the sensor site. Change the application site at least every four hours. More frequent checking may be required due to an individual patient's condition.

Do not use a damaged sensor or one with exposed electrical circuits.

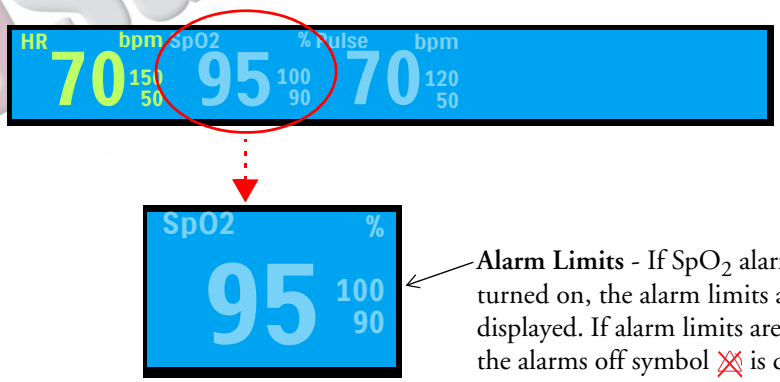
Monitoring SpO_2

To monitor SpO_2 :

1. Connect the appropriate sensor cable to the HeartStart XL+ (see "Connecting the SpO_2 Cable" on page 10).
2. Apply the sensor to the patient.
3. If the HeartStart XL+ is not turned on, turn the Therapy knob to a clinical mode.
   - SpO_2 needs to be configured to appear in AED Mode and does not display unless it is pulsatile.
4. Check that the patient category is appropriate for the patient. If necessary, change the Patient Category to select the appropriate category. See "General Function Buttons" on page 23.

Once the sensor cable is connected and the device is turned on, an SpO_2 measurement begins. A **-?-** is displayed for the SpO_2 value in the Parameter Area while the oxygen saturation is initially measured and value calculated. In a few seconds a value replaces the **-?-**. See Figure 56.

Figure 56 **SpO_2 Value**



Pulse Rate

The patient's pulse rate, as derived from pulse oximetry, is displayed in the Parameter Area. See Figure 57.

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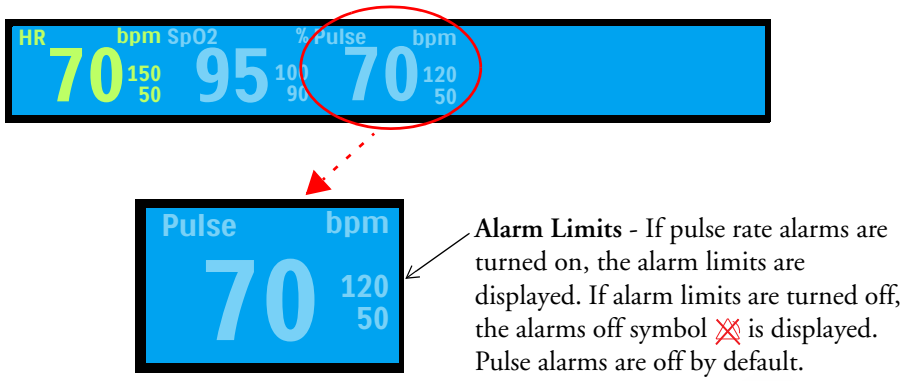
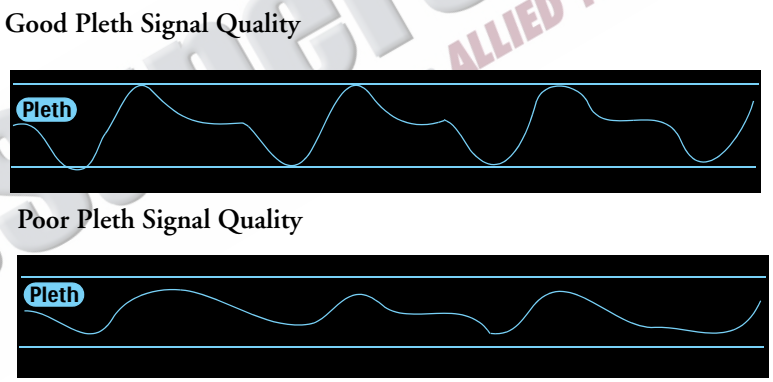
Figure 57 **Pulse Rate Value**



Pleth Wave

When the sensor is connected to the HeartStart XL+, the pleth wave is displayed in the configured Wave Sector. Grid lines are displayed to indicate signal quality. When the signal quality is good, the pleth wave is auto-scaled to the grid lines. When the signal is poor, the size of the wave is proportionally decreased and appears not to reach the grid lines.

Figure 58 **Pleth Waves**



SpO_2 Alarms

Alarms are annunciated if measurements fall outside the configured limits for high or low SpO_2, or if the measurement falls below the configured SpO_2 Desat Limit. SpO_2 alarms, except Desat, are non-latching alarms, meaning they are automatically removed when their alarm condition no longer exists. Desat alarms are latching, meaning they remain present even if the alarm condition no longer exists.

SpO_2 alarms can be generated for the conditions shown in Tables 21 and 22. Once generated, they appear as alarm messages in the SpO_2 alarm status area above the SpO_2 numeric. There are both audio and visual alarms. For more information on alarms, see "Alarms" on page 33.

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Table 21 **SpO_2 Physiological Alarms**

Alarm Message	Condition	Type of Alarm	Indication
Desat	The SpO_2 value has fallen below the Desat low limit.	High Priority Latching Alarm	Red alarm message with audio tone
SpO_2 High	The SpO_2 value exceeds the high alarm limit.	Medium Priority Non-Latching Alarm	Yellow alarm message with audio tone
SpO_2 Low	The SpO_2 value has dropped below the low alarm limit.		

Table 22 **SpO_2 Technical Alarms**

Alarm Message	Condition	Type of Alarm	Indication
SpO_2 Sensor Malfunction	The device is unable to detect a Pleth waveform due to a SpO_2 sensor malfunction.	Low Priority Non-Latching Alarm	Cyan alarm message with audio tone
SpO_2 Unplugged	The SpO_2 sensor is disconnected.		
SpO_2 Noisy Signal	A noisy SpO_2 sensor signal has been detected.		
SpO_2 Interference	Light interference has been detected at the SpO_2 sensor.		
SpO_2 Non-Pulsatile	A non-pulsatile SpO_2 signal has been detected.		
SpO_2 Equipment Malfunction	A problem with the SpO_2 module has been detected.		
SpO_2 Erratic	An erratic measurement has been detected.		
SpO_2 Extended Update	The SpO_2 measurement has not been updated within the last 30 seconds.		
SpO_2 Low Perfusion	The device has detected low perfusion.		
SpO_2 Error	A non-critical failure has been detected.		

NOTES: SpO_2 alarms are on in all clinical modes (except AED and Manual) unless you specifically turn them off or alarms for the entire device are off. Once disabled, alarms remain off until they are turned back on.

While an NBP measurement is in progress, SpO_2 alarms are suppressed.

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SpO_2 Desat Alarm

The SpO_2 Desat alarm provides an additional limit setting below the low limit setting to notify you of potentially life-threatening decreases in oxygen saturation. This additional limit is preset through Configuration Mode.

NOTE: If the SpO_2 Low Limit alarm value is set below the configured SpO_2 Desat Limit, the Desat Limit is automatically adjusted to the SpO_2 Low Limit value. Should the SpO_2 reading fall below this value, the SpO_2 Desat Limit Alarm is announced.

Changing SpO_2 Alarm Limits

◎ **To change the SpO_2 high and low alarm limits:**

1. Press the Menu Select button.
2. Using the Navigation buttons, select **Measurements/Alarms** and press the Menu Select button.
3. Select **SpO_2** and press the Menu Select button.
4. Select **SpO_2 Limits** and press the Menu Select button.
5. Select the new high limit value and press the Menu Select button.
6. Select the new low limit and press the Menu Select button.

Enabling/Disabling SpO_2 Alarms

◎ **To enable/disable SpO_2 alarms:**

1. Press the Menu Select button.
2. Using the Navigation buttons, select **Measurements/Alarms** and press the Menu Select button.
3. Select **SpO_2** and press the Menu Select button.
4. Select **Alarms On** (**Alarms Off**) and press the Menu Select button.

WARNING: Turning alarms off prevents all alarms associated with the SpO_2 measurement from being annunciated. If an alarm condition occurs, no alarm indication is announced.

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Pulse Rate Alarms

You can turn on/off Pulse Rate alarms in all clinical modes where SpO_2 is available. The configured alarm limits may be changed during use. Alarms are annunciated if measurements fall outside the configured limits for high or low pulse rate. All Pulse Rate alarms are categorized as non-latching alarms, meaning they are automatically removed when their alarm condition no longer exists.

Pulse Rate alarms can be generated for the conditions shown in Table 23. Once generated, they appear as alarm messages in the Pulse status area right above the Pulse numeric. There are both audio and visual alerts. For more information on alarms, see "Alarms" on page 33.

Table 23 **Pulse Rate Alarms**

Alarm Message	Condition	Type of Alarm	Indication
Pulse High	Pulse value is greater that the Pulse high alarm limit.	Medium Priority Non-Latching Alarm	Yellow alarm message with audio tone
Pulse Low	Pulse value is less that the Pulse low alarm limit.		

NOTE: Pulse alarms are off by default except when the HeartStart XL+ enters Pacing Mode.

Changing Pulse Rate Alarm Limits

To change the Pulse high and low alarm limits:

1. Press the Menu Select button.
2. Using the Navigation buttons, select **Measurements/Alarms** and press the Menu Select button.
3. Select **Pulse** and press the Menu Select button.
4. Select **Pulse Limits** and press the Menu Select button.
5. Select the new high limit value and press the Menu Select button.
6. Select the new low limit and press the Menu Select button.

Enabling/Disabling Pulse Rate Alarms

To enable/disable Pulse alarms:

1. Press the Menu Select button.
2. Using the Navigation buttons, select **Measurements/Alarms** and press the Menu Select button.
3. Select **Pulse** and press the Menu Select button.
4. Select **Alarms On** (**Alarms Off**) and press the Menu Select button.

Disabling SpO_2 Monitoring

To disable SpO_2 monitoring:

1. Disconnect the sensor cable from the SpO_2 port. The message **SpO_2 Unplugged - Turn Off SpO_2?** appears.
2. Select **Yes** and press the Menu Select button.

NOTE: If the sensor cable is disconnected accidentally, the message **SpO_2 Unplugged - Turn Off SpO_2?** appears. Select **No** and press the Menu Select button. Secure the sensor connection to begin SpO_2 monitoring again.

Caring for Sensors

Refer to the manufacturer's instructions for care and cleaning of your sensors. To get the best results from your reusable sensors, always handle the sensors and cable with care and protect them from sharp objects. The sensor houses a sensitive electronic device that can be damaged. Harsh treatment of the sensor reduces their useful life.

Troubleshooting

If your HeartStart XL+ does not operate as expected during SpO_2 Monitoring, see Table 47 "SpO_2 Monitoring Problems" on page 182.

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Blood Pressure Monitoring

This chapter explains how to monitor blood pressure (NBP) using the HeartStart XL+.

Overview

The HeartStart XL+ measures blood pressure for both adult and infant/child patients using the oscillometric method. Systolic, diastolic and mean measurements are provided. Alarms are available to alert you to changes in the patient's condition.

NBP measurements can be taken in Monitor, Manual Defibrillation (including Synchronized Cardioversion), and Pacing modes. NBP is not available in AED Mode. NBP measurements can be taken automatically on a pre-set schedule or manually on demand.

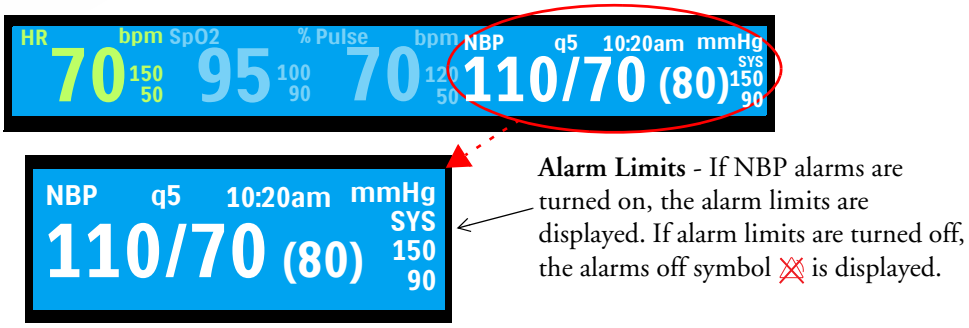
Use the Patient Category button to switch between patient categories.

When pressing the Patient Category button, all parameter alarm limits and initial inflation pressures change to the new patient category. These changes are retained when you switch modes.

- For patients that are ≥ 25kg or ≥ 8 years old, use Adult patient category.
- For patients <25kg or < 8 years old, use Infant/Child patient category.
  The neonatal patient category is not supported.

While an NBP measurement is in progress, the current cuff pressure is displayed in the Parameter area. Once the measurement is complete, the values for systolic, diastolic and mean pressure are displayed along with the measurement schedule (manual or automatic intervals) and a time stamp (see Figure 59.)

Figure 59 **NBP Values**



WARNING: Do not perform NBP monitoring on patients whose upper arm circumference is less than 13cm. Doing so may result in inaccurate measurements.

NOTE: For more information on NBP monitoring, refer to the Application Note *"About Noninvasive Blood Pressure"* available on the Philips website at www.philips.com/ProductDocs.

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Measuring NBP

The first time an NBP measurement is taken, the cuff's initial inflation pressure is 160 mmHg/21 kPa (adult) and 120 mmHg/16 kPa (infant/child). If the measurement is successful, the next inflation pressure is 30 mmHg/4 kPa above the systolic pressure measurement, with a minimum inflation pressure of 120 mmHg/16 kPa. If the patient's initial systolic pressure measurement is higher than the inflation pressure, the inflation pressure is automatically increased by 30 mmHg/4 kPa, and another measurement is attempted. The device aborts a measurement, deflates the cuff and generates an alarm when the inflation pressure exceeds 300 mmHg/40 kPa.

NOTES: Initial cuff inflation pressure is based on the configured patient type – adult or infant/child. If necessary, select the correct patient type during use by changing the Patient Category selection using the Patient Category button on the front of the HeartStart XL+.

For pediatric and adult patient populations, blood pressure measurements made with the Advantage OEM BP Module Series are equivalent to those obtained by trained observers using the cuff/stethoscope auscultatory method within limits prescribed by ANSI/AAMI SP10: 1992 & 2002 (mean error difference of ±5 mmHg or less, standard deviation of 8mmHg or less).

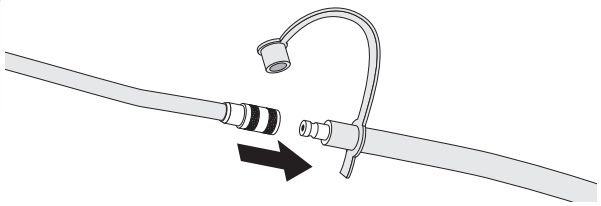
To measure NBP:

1. Select the appropriately sized cuff for the patient. The cuff width should be either 40% of the limb circumference or 2/3 of the upper arm length. The inflatable part of the cuff should be long enough to encircle 50-80% of the limb.

NOTE: Selecting the right cuff size for the patient is important. The wrong cuff size may give false and misleading results. If you do not have the correct cuff size, use a larger one to minimize error.

2. Attach the cuff to the NBP tubing, making sure that air can pass through the tubing and the tubing is not squeezed or kinked. See Figure 60.

Figure 60 **Connecting the NBP Cuff/Tubing**



NOTE: Securely attach the cuff and tubing to prevent accidental disconnections.

3. Insert the NBP tubing into the NBP port as described in "Connecting the NBP Cable" on page 10.
4. Apply the blood pressure cuff to the patient's arm or leg as follows:
   - **a** Ensure that the cuff is completely deflated.
   - **b** Wrap the cuff around the arm, making sure that the artery marker is aligned over the brachial artery. Ensure that:
     - The cuff is not placed on the same extremity as an SpO_2 sensor.
     - The cuff is not wrapped too tightly around the limb. Excessive tightness may cause discoloration and eventual ischemia of the extremities.
     - The NBP tubing from the defibrillator to the cuff is not compressed, crimped or damaged.

c Check that the edge of the cuff falls within the range identified by the <----> markings. If it does not, use a cuff that fits better.

5 Place the limb used for taking the measurement at the same level as the patient's heart.

6 Press the **[Start NBP]** soft key. As the cuff begins to inflate and then deflate, the pressure is displayed.

7 When the measurement is complete, the NBP values are displayed.

To stop an NBP measurement in progress, press the **[Stop NBP]** soft key.

WARNINGS: Do not perform noninvasive blood pressure measurements on patients with sickle-cell disease or any condition where skin damage has occurred or is expected.

Do not use in a hyperbaric chamber.

Care should be taken when using an oscillometric NBP device on patients with decreased consciousness, neuropathy, irregular cardiac rhythm, labile high blood pressure, increased arm activity, or arterial insufficiency especially if the unit is utilized for a prolonged period.

Use clinical judgement to decide whether or not to perform automatic blood pressure measurements on patients with severe blood clotting disorders because of the risk of hematoma in the limb wearing the cuff.

Do not apply the cuff to a limb that has an intravenous infusion or arterial catheter in place. This could cause tissue damage around the catheter when the infusion is slowed or blocked during cuff inflation.

Use only approved cuffs and tubing in order to prevent inaccurate data, injury or damage. All specified cuffs are protected against the effects of the discharge of a defibrillator.

Prolonged series of NBP measurements in automatic mode may be associated with purpura, ischemia and neuropathy in the limb wearing the cuff. When monitoring a patient, examine the extremities of the limb frequently for normal color, warmth and sensitivity. If any abnormality is observed, stop the blood pressure measurements immediately.

Blood pressure readings may be affected by the position of the patient, their physiologic condition, the presence of arrhythmia and other factors.

To obtain accurate blood pressure readings, the cuff must be the correct size and also be correctly fitted to the patient. Incorrect size or incorrect fitting may result in incorrect readings.

CAUTIONS: Do not compress or restrict pressure tubes during an NBP measurement.

If a spill occurs and liquid appears inside the tubing, contact your service personnel.

NOTE: When utilizing NBP, use your clinical judgment on appropriate application for patient's clinical status.

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NBP Schedule

NBP measurements can be taken on a manual or predetermined automatic basis, depending on how the device is configured and the patient's needs:

Manual - There is no schedule for additional measurements. One measurement is taken each time you press the **[Start NBP]** soft key. Take additional measurements by pressing the **[Start NBP]** soft key.

Automatic - A measurement is attempted at configured intervals - every 1, 2.5, 5, 10, 15, 30, 60 or 120 minutes. In order for a measurement to successfully begin, any previous measurement has to have ended, the cuff must be deflated and 30 seconds of rest time elapsed.

NOTE: All criteria must be met in order for an automatic NBP to be taken. For example, if you have the automatic measurement setting set to every 1 minute, the device attempts to take an NBP every 60 seconds. However, for the measurement to successfully begin, the previous measurement must have ended, cuff must be deflated and 30 seconds must have elapsed after cuff deflation. If these criteria are not met, the device waits the 60 seconds to attempt another measurement.

Additional manual measurements can be taken without affecting the automatic measurement schedule by pressing the **[Start NBP]** soft key.

The configured NBP measurements schedule may be changed during an event.

To change the NBP schedule and/or the interval of automatic measurements for the current patient:

1. Press the Menu Select button.
2. Using the Navigation buttons, select **Measurements/Alarms** and press the Menu Select button.
3. Select **NBP** and press the Menu Select button.
4. Select **NBP Frequency** and press the Menu Select button.
5. Select the desired interval and press the Menu Select button.

NOTES: Interval choices are listed in the format "qx" indicating measurements are taken every "x" minutes from the time you first press the **[Start NBP]** soft key.

When cuff measurements are set to be taken at an automatic interval, there is a forced 30-second minimum period in between measurements, even if a measurement is due to be taken. The HeartStart XL+ display shows the last NBP(if obtained in the last 60 minutes), time obtained and frequency.

If no subsequent measurements are taken, NBP values are removed from the display after 60 minutes but can still be obtained through Vital Signs Trending and the Event Summary.

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NBP Alarms

Alarms are annunciated when a measurement for the configured source (systolic, diastolic or mean) falls outside the configured high or low limits. NBP alarms are non-latching alarms, meaning they are automatically removed when their alarm condition no longer exists. Both the source of the alarm and the limits may be changed during an ongoing patient event.

NBP alarms can be generated for the conditions shown in Tables 24 and 25. Once generated, they appear as alarm messages in the NBP alarm status area above the NBP numeric. There are both audio and visual alerts. For more information on alarms, see "Alarms" on page 33.

Table 24 **NBP Physiological Alarms**

Alarm Message	Condition	Type of Alarm	Indication
NBPs High	The NBP systolic value exceeds the high alarm limit.	Medium Priority Non-Latching Alarm	Yellow alarm message with audio tone
NBPd High	The NBP diastolic value exceeds the high alarm limit.		
NBPm High	The NBP mean value exceeds the high alarm limit.		
NBPs Low	The NBP systolic value has fallen below the low alarm limit.		
NBPd Low	The NBP diastolic value has fallen below the low alarm limit.		
NBPm Low	The NBP mean value has fallen below the low alarm limit.		

Table 25 **NBP Technical Alarms**

Alarm Message	Condition	Type of Alarm	Indication
NBP Cuff Overpressure	The cuff pressure exceeded 300 mmHg/40 kPa.	Low Priority Non-Latching Alarm	Cyan alarm message with audio tone
NBP Cuff Not Deflated	The cuff has failed to deflate.		
NBP Measurement Failed	The device is unable to complete a measurement.		
NBP Calibration Overdue	NBP module calibration is due.		
NBP Equipment Malfunction	A problem with the NBP module has been detected.		
NBP Error	A non-critical failure has been detected.		

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NOTE: NBP alarms are on unless you specifically turn them off or alarms for the entire device are off. Once disabled, alarms remain off until they are turned back on.

Changing NBP Alarm and Source Limits

To change the NBP alarm source and/or limits:

1. Press the Menu Select button.
2. Using the Navigation buttons, select **Measurements/Alarms** and press the Menu Select button.
3. Select **NBP** and press the Menu Select button.
4. Select **NBP Limits** and press the Menu Select button.
5. Select the desired source for the alarm (**Systolic**, **Diastolic** or **Mean**) and press the Menu Select button.
6. Select the new high limit value and press the Menu Select button.
7. Select the new low limit and press the Menu Select button.

Enabling/Disabling NBP Alarms

To enable/disable NBP alarms:

1. Press the Menu Select button.
2. Using the Navigation buttons, select **Measurements/Alarms** and press the Menu Select button.
3. Select **NBP** and press the Menu Select button.
4. Select **Alarms On** (**Alarms Off**) and press the Menu Select button.

WARNING: Turning alarms off prevents all alarms associated with the NBP measurement from being annunciated. If an alarm condition occurs, no alarm indication is announced.

Caring for Cuffs

Refer to the manufacturer's instructions for care and cleaning of your NBP cuffs. To get the best results from your cuffs, handle them with care and protect them from sharp objects.

NBP Calibration

NBP should be calibrated yearly. To calibrate the NBP module, call for service or refer to the *HeartStart XL+ Service Manual*.

Troubleshooting

If your HeartStart XL+ does not operate as expected during NBP Monitoring, see Table 48 "NBP Monitoring Problems" on page 184.

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11

Trending

This chapter describes how to review patient data using HeartStart XL+ Trending.

Overview

In Monitor Mode your HeartStart XL+ provides the ability to view and print numeric vital signs trending data for the current incident. Trending data are automatically acquired if parameters are on.

When viewing trending data, the Trending Report is displayed in the HeartStart XL+'s lower two wave sectors and takes over the soft key functions. Trend data can be displayed at selected intervals for up to 8 hours of monitoring. You can set your trend interval to 1, 5, 10, 15, 30 or 60 minutes.

Trending data displayed for parameters continuously measured (heart rate, SpO_2, and pulse) are the average of multiple measurements over the trend time period. Trending data for NBP appear with the timestamp of the measurement.

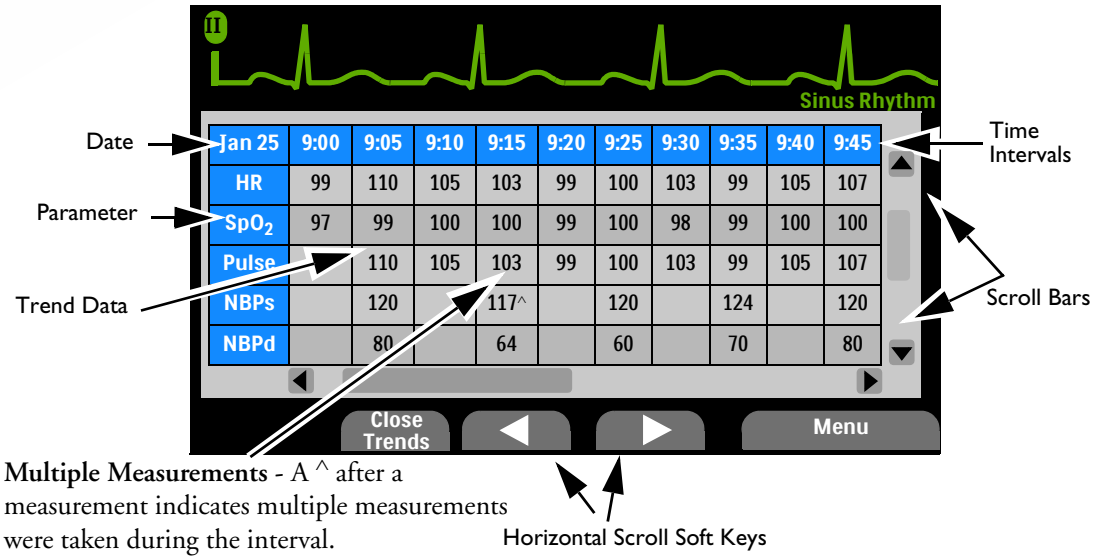
Viewing Trend Data

To view trending data:

1. Confirm your HeartStart XL+ is in Monitor Mode.
2. Press the Menu Select button.
3. Using the Navigation buttons, select **Trends** and press the Menu Select button. The Trending Report takes over the bottom two wave sectors. See Figure 61.

To close the Trends Report, press the **[Close Trends]** soft key.

Figure 61 **Trending Report**


II
Sinus Rhythm
Date
Parameter
Trend Data
Time Intervals
Scroll Bars
Jan 25 | 9:00 | 9:05 | 9:10 | 9:15 | 9:20 | 9:25 | 9:30 | 9:35 | 9:40 | 9:45
HR | 99 | 110 | 105 | 103 | 99 | 100 | 103 | 99 | 105 | 107
SpO2 | 97 | 99 | 100 | 100 | 99 | 100 | 98 | 99 | 100 | 100
Pulse | | 110 | 105 | 103 | 99 | 100 | 103 | 99 | 105 | 107
NBPs | | 120 | | 117^ | | 120 | | 124 | | 120
NBPd | | 80 | | 64 | | 60 | | 70 | | 80
Close Trends
Menu
Multiple Measurements - A ^ after a measurement indicates multiple measurements were taken during the interval.
Horizontal Scroll Soft Keys

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About the Data Displayed

- When trending is initially displayed, the most recent trending data appear in the far right column.
- The display automatically updates as new data become available, with the newest data appearing in the far right column of the display and older data moving over to the left. If the display is full, the oldest displayed data is removed.
- If you scroll horizontally to view older data, the HeartStart XL+ updates the newest data when you scroll back.
- If a parameter data point has invalid information, a **-?-** is displayed. Questionable data are indicated by a question mark just before the numeric value. Unavailable data are indicated by a blank space.
- If a parameter has not been measured during the display period, it is not listed in the far left column.
- The Heart Rate parameter is always the top entry in the Trends Report. If your device has the SpO_2 Option and values for SpO_2 and Pulse are available, they are listed second and third in the Trend Report. If your device has the NBP option and values for NBP are available, they are listed fourth in the Trends Report.
- The units of measure for trend data are not displayed in the Trend table and report.

Setting Trend Intervals

Trending data can be shown at selected intervals for up to the last 8 hours of monitoring. You can adjust the display's time interval for the current incident to 1, 5, 10, 15, 30 or 60 minutes. The default is 5 minutes.

To adjust the Trend Interval:

1. Confirm there is a Trends Report on the HeartStart XL+ screen.
2. Press the Menu Select button.
3. Using the Navigation buttons, select **Trend Interval** and press the Menu Select button.
4. Select the interval you want and press the Menu Select button.

Navigating Around the Trending Report

Use the horizontal scroll soft keys to scroll left and right (backward and forward in time) in the Trending Report. The soft key is inactive (grayed out) if there is no more data to be viewed in that direction.

If there are more lines of data than can be shown on the screen, use the Navigation buttons next to the Menu Select button to scroll up and down the display.

NOTE: Make sure there are no active menus before using the Navigation buttons to scroll up and down the Trends Report. If you do have an active menu, exit the menu before trying to scroll up or down in the Trends Report.

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Printing the Trends Report

You can print a Trends Report with or without a Trending report on the HeartStart XL+'s display.

To print a Trends Report from Monitor Mode:

1 Press the Report button .

2 Using the Navigation buttons, select **Trends** and then the appropriate interval.

A report for the entire event period is printed. See Figure 62.

Figure 62 **Sample Trends Printed Report**

Trends Header Page:

Trend Report
Event ID: (xxxxxxxx)
(Patient Name)
Patient ID: (xxxxxxxx)
Patient Sex: (M or F)
(Incident Date)
HeartStart XL+
S/N: (Device Serial Number)
(Software revision)

Trends Data Page:

(date)		9:45	9:40	9:35	9:30	9:25	9:20	9:15	9:10	9:05	9:00
HR	bpm	107	105	99	103	100	99	103	105	110	99
SpO2	%	100	100	99	98	100	99	100	100	99	97
Pulse	bpm	107	105	99	103	100	99	103	105	110	99
NBPs	mmHg		120		120		117		120		118
NBPd	mmHg		70		60		64		70		65
NBPm	mmHg		82		80		81		82		81
			9:39		9:29		9:19		9:09		8:59

NOTE: Text Data appearing in parenthesis in Figure 62 are replaced by patient information in an actual Trends Printed Report. For example: (Patient Name) is replaced with the patient's name if available.

Trends Reports can also be printed from Data Management Mode. See "Printing While in Data Management Mode" on page 133.

NOTE: Do note enter Data Management Mode while monitoring a patient.

Troubleshooting

If your HeartStart XL+ does not operate as expected during trending, see "Troubleshooting" on page 173.

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12

Data Management

This chapter describes the data management features of the HeartStart XL+, including Data Management Mode, Event Summary, printing functionality and Mark Events.

Overview

The HeartStart XL+ automatically generates an Event Summary for each patient event. Each Event Summary is assigned a unique event identification number, is date/time stamped and stored in the device's internal memory. Data related to the current event is available for viewing, reporting, and printing. Vital sign parameters are part of the Event Summary but are also available in the Trends Report (see "Trending" on page 115.)

The current Event Summary or Trends Report may be printed by pressing the Reports button on the front of the HeartStart XL+.

When the internal memory is full, each additional summary causes one or more of the oldest event summaries to be overwritten.

Event Summaries stored in internal memory can be:

- Printed.
- Copied to a USB flash drive in Data Management Mode for transfer to a data management application.

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Event Summary

A new Event Summary is initiated the first time one of the following occurs after the device is powered on:

- The arrival of a valid ECG signal either through electrodes or pads/paddles.
- The arrival of valid SpO_2 data.
- The arrival of valid NBP data.
- The Charge button is pressed.
- The Mark Event button is pressed.

NOTE: There is an 8-hour data limit per incident for an Event Summary. When the 8-hour limit is reached, the HeartStart XL+ stops recording and a message is displayed on the HeartStart XL+. The number of Event Summaries that can be stored is related to the duration of each individual Event Summary. For example, the HeartStart XL+ can store approximately 50 Event Summaries of approximately 30 minutes in length or 5 Event Summaries of approximately 8 hours in length.

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Event Summary Data Collected

Patient data collected, if available, includes:

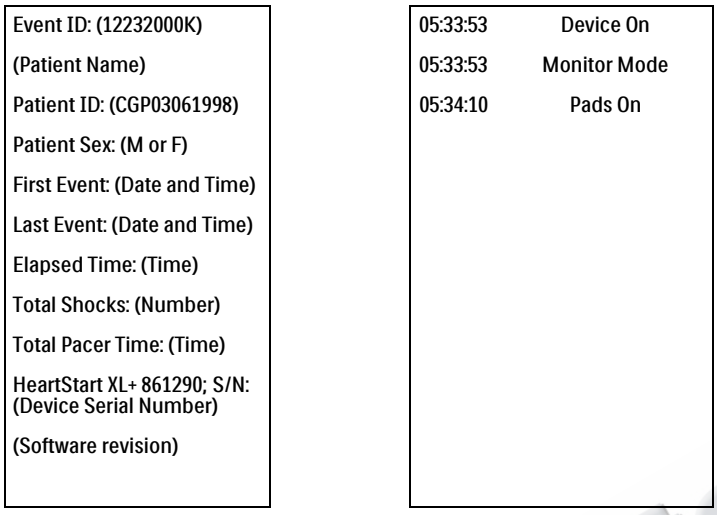
- Two ECG waveforms with beat labels
- One pleth waveform
- Patient event information including:
  - Patient name, sex, category, ID
  - Parameter information/Trends data
  - Physiological alarms and alarm limits
  - Defibrillation and pacing events
  - Mark events
- Technical/device event information including:
  - Power on/off
  - Technical alarms
  - Initial mode and mode changes
  - Initial battery status and subsequent changes
  - Print Strip
- Research data, including waves (AED Mode only) and shock/no shock decisions

You can configure the HeartStart XL+ to save short or long Event Summaries. Short Event Summaries include all the above information except waveforms. Long Event Summaries contain everything.

Printing an Event Summary

You can print an Event Summary Report (see Figure 63) during a patient event or from Data Management Mode after the event has concluded. See "Printing While in Data Management Mode" on page 133.

Figure 63 **Sample Printed Event Summary Report**


Event ID: (12232000K)
(Patient Name)
Patient ID: (CGP03061998)
Patient Sex: (M or F)
First Event: (Date and Time)
Last Event: (Date and Time)
Elapsed Time: (Time)
Total Shocks: (Number)
Total Pacer Time: (Time)
HeartStart XL+ 861290; S/N: (Device Serial Number)
(Software revision)
05:33:53 Device On
05:33:53 Monitor Mode
05:34:10 Pads On
Alarm Identification:
High priority physiological alarms are preceded by ***. Medium priority physiological alarms are preceded by **. High priority technical alarms are preceded by !!!. Medium priority alarms are preceded by !!. Low priority alarms are not preceded by any marks.

NOTE: Text Data appearing in parenthesis in Figure 63 is replaced by patient information in an actual Event Summary. For example: (Patient Name) is replaced with the patient's name if it has been logged.

Events Stored in an Event Summary

Events and wave segments can be stored in an Event Summary. Table 26 lists events and related information stored in an Event Summary. Not all events listed are possible, based on your device's configuration. Text in parenthesis are replaced by an appropriate value.

To have waves stored in the Event Summary you must have the HeartStart XL+ configured for long Event Summaries. See Table 38 on page 145. Segments include a header, waveform and events.

NOTES: If an Event Summary stops printing because the paper runs out, the report resumes printing if a new roll of paper is installed within 3.5 minutes.

Values listed on a printed Event Summary also include the parameter's unit of measurement.

Table 26 **Event Information**

Logged Event	Frequency
Power-related events	
Device On	Logged when device first turns on.
Continued Use	Logged when device is turned on after being turned off for less than 10 seconds.
Device Off	Logged when the Therapy knob is turned to the **Off** position.
RFU Failure	Logged when a critical device failure has been reported.
Mode and Energy Positions	
AED Mode	Logged at the start of an event and when mode or selected energy changes.
Monitor Mode	
Pacer Mode	
Manual Defib Mode	
Sync Mode	
(value) J	
Exit Clinical Mode	Logged when exiting a clinical mode.
Patient Info	
Adult or Infant/Child	Logged when patient category is set or changed.
Paced, Non-Paced, Pacing Status Unknown	Logged when internal paced status is set or changed.
Battery Status	
Low Battery	Logged when battery is low.
Pacing on Low Battery	Logged when you are pacing and the battery is low.
Shutting Down in 1 min	Logged when imminent shutdown warning is issued.
Shutting Down Now	Logged when shutdown warning is issued.
Battery Calibration Required	Logged when Op Check detects that the battery needs calibration.
Battery Charge Good	Logged when the battery charge level is good.
Battery Not Present	Logged when the battery is not present.
Pads/Paddles/Leads	
Pads On	Logged when pads are applied to the patient.
Pads Off	Logged after a **Pads On** event if the multifunction electrode pads are removed from the patient or the Therapy cable is disconnected.
Pads Shorted	Logged when a pad impedance is low.
Pads Marginal	Logged when pad impedance is minimal.
External Paddles On	Logged when external paddles make contact with the patient.
External Paddles Off	Logged after **External Paddles On** if paddles lose contact with the patient.

Table 26 **Event Information *(Continued)***

Logged Event	Frequency
Internal Paddles On	Logged when internal paddles make contact with the patient.
Internal Paddles Off	Logged after **Internal Paddles On** if paddles lose contact with the patient.
Leads On	Logged when monitoring electrodes for primary ECG are attached to the patient.
Leads Off	Logged after **Leads On** if a monitoring electrode for the primary wave loses contact with the patient.
Vitals	
HR (value), SpO_2 (value), Pulse (value), NBP (value)	Values logged when measurement is taken - a minimum of every 5 minutes.
HR/ECG	
Asystole	Logged when a high priority latching physiological alarm is generated.
V-Fib/V-Tach	
V-Tach	
Extreme Brady (value) < (limit)	
Extreme Tachy (value) > (limit)	
Pacer Not Capture	Logged when a medium priority latching physiological alarm is generated and Pacer Mode is selected.
Pacer Not Pace	
PVC (xx) > Limit/Min.	Logged when a medium priority non-latching physiological alarm is generated.
HR High (value) > (limit)	
HR Low (value) < (limit)	
Cannot Analyze ECG	Logged when there is ECG data that cannot be analyzed.
ECG Equipment Malfunction	Logged when there has been an ECG equipment malfunction.
Pads ECG Equipment Malfunction	Logged when there has been a ECG pads (or paddles) equipment malfunction.
ECG Alarms On/Off	Logged when ECG alarms are turned off or on and any subsequent change.
HR Limits (low) (high)	Logged when HR alarms are turned on and when there is a change in alarm limits.
VTACH Limits HR (limit) Run (limit)	Logged when VTACH alarms are turned on and when there is a change in alarm limits.
PVC/min Limit (limit)	Logged when PVC rate alarms are turned on and when there is a change in alarm limits.
Learning ECG	Logged when the HeartStart XL+ is evaluating the ECG signal.
Learning Rhythm	Logged when the HeartStart XL+ is evaluating the ECG rhythm.
ECG bandwidth for Display (setting), for Printing (setting)	Initial ECG bandwidth for display, printing and storage are logged.

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Table 26 **Event Information *(Continued)***

Logged Event	Frequency
Equipment Disabled: Therapy	Logged when the device detects a therapy equipment failure.
SpO_2	
SpO_2 On/Off	Logged when SpO_2 monitoring is connected and any subsequent disconnect/connect.
SpO_2 High (value) > (limit)	Logged when the patient's SpO_2 value is higher than the configured limit.
SpO_2 Low (value) < (limit)	Logged when the patient's SpO_2 value is lower than the configured limit.
Desat (value)< (limit)	Logged when the patient's Desat value is lower than the configured limit.
SpO_2 Sensor Malfunction	Logged when the device is on and unable to acquire a Pleth waveform.
SpO_2 Unplugged	Logged when SpO_2 monitoring is on and the sensor is disconnected.
SpO_2 Noisy Signal	Logged when SpO_2 is on and a noisy signal is detected.
SpO_2 Interference	Logged when SpO_2 is on and light interference is detected at the SpO_2 sensor.
SpO_2 Non-Pulsatile	Logged when SpO_2 is on and a non-pulsatile SpO_2 sensor signal is detected.
SpO_2 Equipment Malfunction	Logged when SpO_2 is on and an SpO_2 equipment malfunction is detected.
SpO_2 Erratic	Logged when SpO_2 is on and an erratic measurement condition occurs.
SpO_2 Extended Update	Logged when SpO_2 is on and the SpO_2 measurement update period exceeds 30 seconds.
SpO_2 Low Perfusion	Logged when SpO_2 is on and low perfusion occurs.
SpO_2 Error	Logged when a non-critical SpO_2 error is detected.
SpO_2 Alarms On/Off	Logged when SpO_2 alarms are turned on or off and any subsequent change.
SpO_2 Limits (low) (high) Desat (limit)	Logged when SpO_2 alarms are turned on and when there is a change in alarm limits.
Pulse	
Pulse High (value) > (limit)	Logged when the patient's pulse is higher than the configured limit.
Pulse Low (value) < (limit)	Logged when the patient's pulse is lower than the configured limit.
Pulse Alarms On/Off	Logged when pulse alarms are turned on or off and any subsequent change.
Pulse Limits (low limit) (high limit)	Logged when pulse alarms are turned on and when there is a change in alarm limits.
NBP	
NBP On Manual	Logged when a manual NBP measurement is requested.
NBP On (frequency value)	Logged when an automatic NBP measurement is requested (including the frequency value).
NBP Frequency Manual	Logged when an automatic NBP measurement is changed to manual (including the frequency value).
NBP Frequency (frequency value)	Logged when the NBP frequency is changed.

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Table 26 **Event Information *(Continued)***

Logged Event	Frequency
NBP Alarms Off/On	Logged when NBP alarms are turned on or off and any subsequent change.
NBP Limits Systolic (low value, high value)	Logged when the Systolic NBP alarm limit is changed.
NBP Limits Diastolic (low value, high value)	Logged when the Diastolic NBP alarm limit is changed.
NBP Limits Mean (low value, high value)	Logged when the Mean NBP alarm limit is changed.
NBPs High (value) > (limit)	Logged when the patient's Systolic NBP is higher than the configured limit.
NBPs Low (value) < (limit)	Logged when the patient's Systolic NBP is lower than the configured limit.
NBPd High (value) > (limit)	Logged when the patient's Diastolic NBP is higher than the configured limit.
NBPd Low (value) < (limit)	Logged when the patient's Diastolic NBP is lower than the configured limit.
NBPm High (value) > (limit)	Logged when the patient's Mean NBP is higher than the configured limit.
NBPm Low (value) < (limit)	Logged when the patient's Mean NBP is lower than the configured limit.
NBP Calibration Overdue	Logged when NBP module calibration is due.
NBP Cuff Not Deflated	Logged when the NBP cuff fails to deflate after 3 minutes.
NBP Cuff Overpressure	Logged when the NBP cuff pressure reaches 300 mmHg/40 kPa.
NBP Measurement Failed	Logged when an NBP measurement fails to complete.
NBP Error	Logged when the device detects a non-critical NBP failure.
NBP Equipment Malfunction	Logged when the NBP module detects a malfunction.
Defibrillation	
Charging to (value) J	Logged when charging is initiated.
Disarm Manual	Logged when the device is disarmed manually.

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Table 26 **Event Information *(Continued)***

Logged Event	Frequency
Disarm Auto (reason)	Logged when the device disarms automatically. Reasons include: **Pads Off:** Logged when the automatic disarm is caused by a bad connection between the device and the patient. **Shock Equipment Malfunction:** Logged when the device is unable to reach the selected energy during charging. **Timeout:** Logged when the device reaches its configured auto-disarm period. **Shock Aborted:** Logged when the shock is aborted. **No Shock Advised:** Logged when, in AED Mode, the algorithm determines the rhythm is not shockable. **Device Off:** Logged when the device is turned off while charged. **Leads Off:** Logged in Synchronized Cardioversion Mode when a leads off condition is detected in the synchronizing lead. **Pads/Paddle Type Unknown:** Logged when, with the therapy cable connected, the device detects a change in the paddles or pads type or if the therapy cable type identification is not valid.
Shock # (number) (energy) J (impedance) (peak current) A	Logged when a shock is delivered.
Shock Aborted (impedance)	Logged when a shock is initiated but aborted before a full shock dose is delivered.
Sync On/Off	Logged when Sync is turned on or off and any subsequent change.
Abnormal Shock Dose	Logged when a shock is initiated and completed but the full dose is not delivered.
AED Mode	
Analyzing	Logged when the algorithm begins analysis.
Artifact Detected	Logged when artifact has been detected.
Shock Advised	Logged when the algorithm detects a shockable rhythm.
No Shock Advised	Logged when the algorithm detects a non-shockable rhythm.
Cannot Analyze ECG	Logged when the algorithm is unable to make a shock/no shock decision.
Forced Pause	Logged when the device enters or exits a forced pause.
NSA Pause	Logged when the device enters or exits a NSA pause.
NSA Monitoring	Logged when the device enters or exits NSA monitoring.
CPR Pause	Logged when the device enters or exits CPR pause.
Pacing	
Pacer Mode Demand/Fixed	Logged when pacing starts and when the mode is changed.
Pacer Rate (value) ppm	Logged when the Pacer Rate is changed.
Pacer Output (value) mA	Logged when the Pacer Output is changed.
Pacing Paused	Logged when pacing is paused.

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Table 26 **Event Information *(Continued)***

Logged Event	Frequency
Pacer Started (rate) ppm (current) mA (width) ms	Logged when pacing starts.
Pacing Stopped. Power Interrupted.	Logged when power is restored if pacing is interrupted or stopped due to a power loss and the Therapy knob remains in the Pacer position.
Pacer Output Low	Logged when the Pacer Output is less than the selected setting by 20 percent or 10mA (whichever is greater).
Pacing Stopped (reason)	Logged when the device stops pacing. Reasons include: **Pads Off:** Logged when a pads off condition is detected. **Device Error:** Logged when a device error that prevents delivery of pacing therapy is detected. **Pads Cable Off:** Logged when the Therapy cable is disconnected from the device. **Leads Off:** Logged when there is a leads-off condition with the primary ECG lead for pacing.
Mark Event	
Mark Event	Logged when the Mark Event button is pressed.
(Configured Event Text)	Logged when you select an entry from the Mark Event menu.
Printing	
Print Strip	Logged when you hit the Print button on the front of the device.
Printer Test Failure	Logged when there is a printer failure during an Operational Check.
Alarms	
Alarms On/Off	Logged when alarms are enabled/disabled.
All Alarm Audio Pause	Logged when alarm audio is paused.
All Alarm Audio Off	Logged when alarm audio is turned off.
Active Alarms Audio Paused	Logged when an active alarm's audio is paused.
Active Alarms Audio Off	Logged when an active alarm's audio is turned off.

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Data Management Mode

Data Management Mode is a non-clinical mode used to manage event data records. You can print or export an individual Event Summary or export all Event Summaries. You can also configure the HeartStart XL+ to remove patient information from Event Summaries prior to exporting them. And you can also manage Event Summary data on the external USB drive.

NOTE: Do not enter Data Management Mode while monitoring a patient.

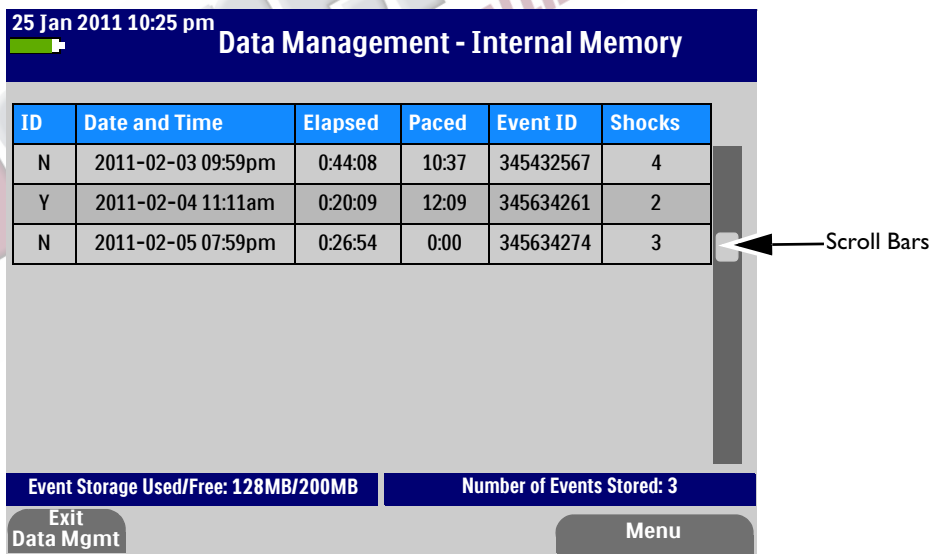
To enter Data Management Mode:

1. Turn the Therapy knob to either **Monitor**, **Pacer** or **Manual Defib.**
2. Press the Menu Select button.
3. Using the Navigation buttons, select **Other** and press the Menu Select button.
4. Select **Data Management** and press the Menu Select button.
5. Confirm your selection. Use the Navigation buttons to select **Yes** and press the Menu Select button. If you select **No**, you are returned to the mode you started from.

Internal Memory

When first entering Data Management Mode, the Internal Memory Screen is displayed. See Figure 64.

Figure 64 **Data Management Internal Memory**



The following information is listed on the display:

- **ID** – Indicates if the event data record contains any patient information which could uniquely identify the individual. **Y** indicates there is; **N** indicates there isn't.
- **Date and Time** – Date and time the event began.
- **Elapsed** –Duration of the event.
- **Paced** – Total paced time for the event.
- **Event ID** – The unique ID for the event.
- **Shocks** – Total number of shocks delivered during the event.
- **Event Storage Used/ Free** – The amount of space used/available in internal memory.
- **Number of Events Stored** – The number of events that are currently stored in internal memory.

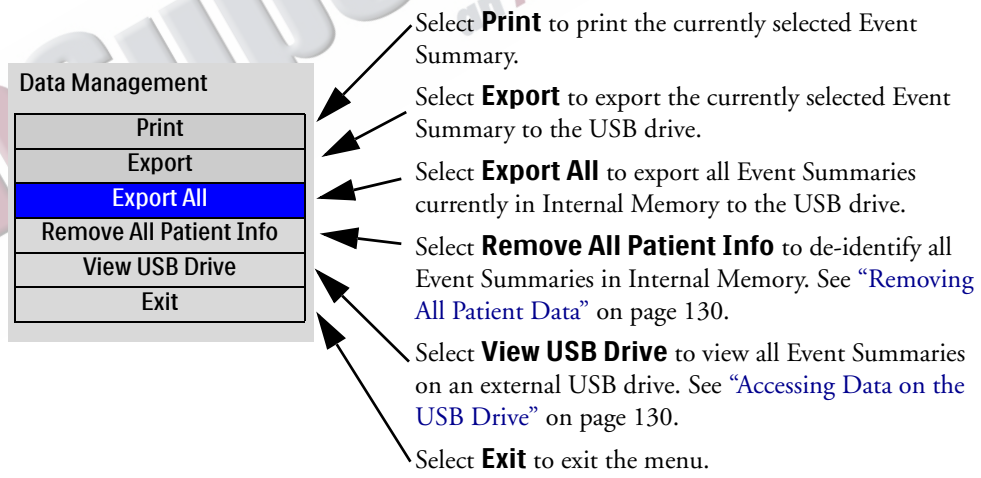
Internal Memory Menu

From the Internal Memory Menu you can print, export, remove all patient identification data and view data on your USB drive.

To use the Internal Memory Menu:

1. Confirm you are in Data Management Mode.
2. Press the Menu Select button.
3. Using the Navigation buttons, select your desired operation. See Figure 65.

Figure 65 **Internal Memory Menu**


Data Management
Print
Export
Export All
Remove All Patient Info
View USB Drive
Exit
Select Print to print the currently selected Event Summary.
Select Export to export the currently selected Event Summary to the USB drive.
Select Export All to export all Event Summaries currently in Internal Memory to the USB drive.
Select Remove All Patient Info to de-identify all Event Summaries in Internal Memory. See "Removing All Patient Data" on page 130.
Select View USB Drive to view all Event Summaries on an external USB drive. See "Accessing Data on the USB Drive" on page 130.
Select Exit to exit the menu.

4. Press the Menu Select button to perform the task.

NOTES: Select **Cancel Export** from the Data Management Menu to cancel an export once it begins. The option appears in the menu after you have begun to print/export. To cancel printing, hit the Print button.

If you change from Data Management Mode to a clinical mode while data is exporting, you are alerted that data export is in process and asked to **Stop Exporting?** Select **Yes** to stop data export and continue to the new mode. Select **No** to continue exporting data.

If you turn the device off while exporting data, the export is stopped and the exported data might be incomplete.

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Removing All Patient Data

In Data Management Mode, you can de-identify patient Event Summaries two ways. Patient-related data include name, medical record number, dates related to the individual, patient age if over 89 and any other information that could uniquely identify an individual.

- When exporting Event Summaries, the HeartStart XL+ can be configured to prompt you to remove all patient-related data prior to exporting. If this function is enabled, you are prompted to **Export Without Patient Info?** Select **Yes** to remove the patient-related data prior to exporting and **No** to export with patient-related data in the Event Summary.
- When the Internal Memory Menu is displayed (Figure 65), selecting **Remove All Patient Info** prompts the HeartStart XL+ to ask you **Remove Patient Info from All Internal Event Data?** Select **Yes** to remove the patient-related data and **No** to keep the patient-related data in the Event Summary.

Accessing Data on the USB Drive

When you select the **View USB Drive** option from the Internal Memory Menu, the HeartStart XL+ first checks that there is a compatible USB drive inserted into the USB port on top of the device (see "USB Data Port" on page 12). If a compatible USB drive is not found, the Internal Memory Screen remains on the display. If a compatible drive is found, then the USB Drive Screen is displayed.

NOTE: The USB Drive Screen's layout is similar to the Internal Memory Screen (see Figure 64) except **Internal Memory** is replaced with **USB Drive** in the screen's title.

Using the HeartStart XL+, you are only able to save Event Summaries to and delete from the USB drive. Additional USB drive operations can be performed with a USB-compatible computer.

Saving Data to the USB Drive

You can save data to a USB drive from Data Management Mode, Configuration Mode and after an Operational Check.

To save data to a USB Drive:

1. Confirm you have a USB drive inserted into the USB port.
2. Press the **[Export]** soft key or press the Menu Select button and select **Export** from the menu. The HeartStart XL+ copies your data to the USB drive.

NOTE: If data exporting is in process and you change from a non-clinical mode to a clinical mode or vice versa, the HeartStart XL+ asks you if you wish to continue exporting. Select **Yes** to stop; **No** to continue with the export.

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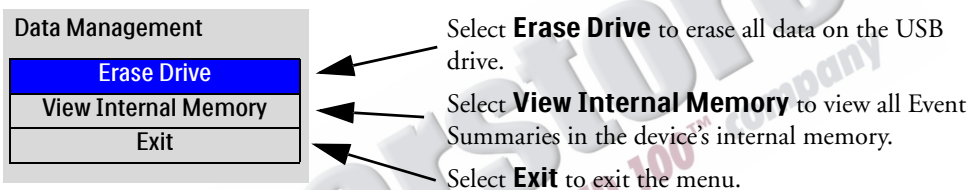
Deleting Event Summaries from the USB Drive

To delete Event Summaries from the USB drive:

1. Confirm you are in Data Management Mode.
2. Press the Menu Select button.
3. Using the Navigation buttons, select **View USB Drive** and press the Menu Select button.
4. Once in the USB Drive Screen, press the Menu Select button.
5. The USB Drive Menu appears. See Figure 66.
6. Using the Navigation buttons, select **Erase Drive.**
7. Press the Menu Select button to erase all event summaries from the USB drive.
8. HeartStart XL+ prompts you to confirm your selection. Select **Yes** to erase all data on the drive. Select **No** to leave all data on the drive.

Figure 66 **USB Drive Menu**


Data Management
Erase Drive
View Internal Memory
Exit
Select Erase Drive to erase all data on the USB drive.
Select View Internal Memory to view all Event Summaries in the device's internal memory.
Select Exit to exit the menu.

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Printing Data

The HeartStart XL+ can print multiple pieces of information in both clinical and non-clinical modes. The device can be configured to print automatically when certain events occur or you can initiate a print request at any time during an event.

Printing During a Patient Event

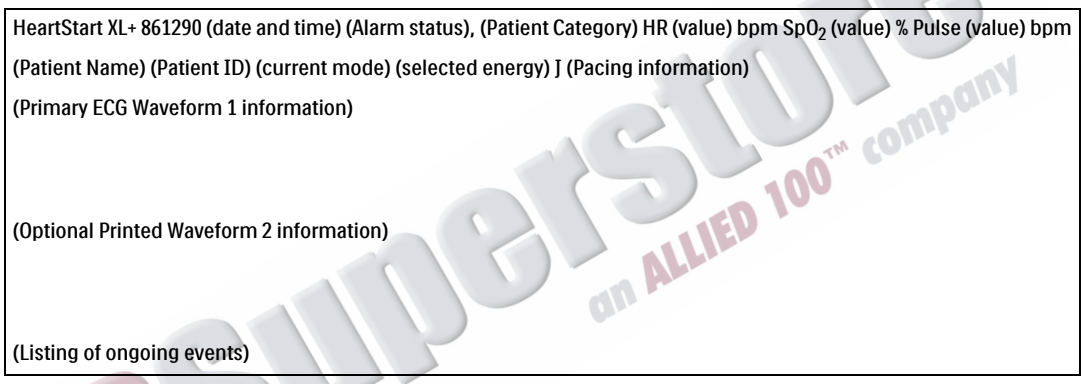
The HeartStart XL+ allows you to print various data reports in a clinical mode during a patient event.

To print a strip during an event:

1 Press the Print button .

The printed strip (see Figure 67) contains the header information, configured waveforms, wave markings (R-Wave Arrows, Pacing Markers) and events, including event markers. See Table 27.

Figure 67 **Sample Printed Strip**


HeartStart XL+ 861290 (date and time) (Alarm status), (Patient Category) HR (value) bpm SpO2 (value) % Pulse (value) bpm
(Patient Name) (Patient ID) (current mode) (selected energy) J (Pacing information)
(Primary ECG Waveform 1 information)
(Optional Printed Waveform 2 information)
(Listing of ongoing events)

NOTE: Text Data appearing in parenthesis in Figure 67 are replaced by patient information in an actual Printed Strip. For example: (Patient Name) is replaced with the patient's name if available.

Table 27 **Event Markers**

Event	Symbol
Mark Event	▶
Physiological Alarm	△
Shock Delivered	⚡

The HeartStart XL+ can also be configured to print a strip when an alarm, charge, shock or mark event occurs. See "Printing Settings" on page 138.

To print an Event Summary for the current event:

1 Press the Report button .

2 Using the Navigation buttons, select **Event Summary** and press the Menu Select button.

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Printing While in Data Management Mode

To print a Event Summary contained in Internal Memory:

1. Select the Event Summary you wish to print.
2. Press the Menu Select button and select **Print**.
   OR
   Press the Report button , select **Event Summary** from the listing and press the Menu Select button to print.

To print a Trends Report related to an Event Summary contained in Internal Memory:

1. Select the Event Summary that contains the Trends Report you wish to print.
2. Press the Report button , select **Trends** from the listing and press the Menu Select button.
3. Using the Navigation buttons, select the Trend Interval you want. Press the Menu Select button to begin printing.

NOTES: To see how to install printer paper rolls, see "Installing Paper" on page 18.

If you change from a clinical to non-clinical mode during printing, the HeartStart XL+ ask if you want to to stop printing. Select **Yes** to stop printing and **No** to continue printing.

If you have manually started printing a strip and the HeartStart XL+ tries to automatically initiate a strip, the automated print strip is ignored.

If the HeartStart XL+ automatically initiates a print strip and then automatically initiates another print strip, the first strip is extended to include data through the end time of the second strip.

If a request to print a data report is made while the printer is currently printing another report, the HeartStart XL+ prompts you with questions. Your answers determine which report takes precedence for printing.

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Mark Events

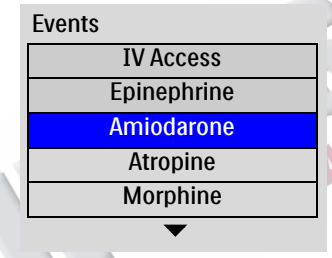
The Mark Events button allows you to annotate the Event Summary and ECG strip when the button is pressed. If configured, pressing the Mark Event button prints a 10-second ECG strip leading up to the event, the event itself, and the 5 seconds after the event.

To mark an event:

1. Press the Mark Event button. The Event Menu (see Figure 68) is displayed.
2. Using the Navigation buttons, select the desired event.
3. Press the Menu Select button to mark the event. If configured, an ECG strip prints including the mark event symbol and the selected event label.

NOTE: If the Mark Event button is pressed and no event is selected from the Event Menu within 5 seconds, the Event Menu is removed from the screen and a generic event is logged. If the Mark Event button is pressed a second time within 5 seconds of the first one, a generic event is logged and the Event menu screen remains on the display for 5 seconds.

Figure 68 **Events Menu**



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Configuration

This chapter describes the configurable parameters of the HeartStart XL+ and procedures for modifying configuration.

Overview

Configuration settings allow you to customize the HeartStart XL+ to meet your needs. Configuration is viewed and changed through the Configuration Menu. A password is required to change your device's configuration.

NOTES: As you are making configuration choices, consider all the clinical environments the HeartStart XL+ may be used in. Choices for one department might not be suitable for another department.

The change configuration password is printed on the front of the *HeartStart XL+ User Documentation* CD-ROM.

Entering Configuration Mode

Once you enter Configuration Mode without a password, you can view, print or export configuration settings and you can also change the date and time. Once you enter the password, you can view, change, print, save and export configuration settings. New configuration settings are not saved until you press the **[Save Changes]** soft key.

WARNING: Do not perform configuration activities while the HeartStart XL+ is connected to a patient.

Accessing Configuration Mode

To access Configuration Mode:

1. Turn the Therapy knob to **Monitor**, **Manual Defibrillation** or **Pacer**.
2. Press the Menu Select button.
3. Using the Navigation buttons, select **Other** and press the Menu Select button.
4. Select **Configuration** and press the Menu Select button.
5. To confirm your selection, select **Yes** and press the Menu Select button. If you select **No**, you are returned to the mode you started from.

Once in Configuration Mode, press the **[Exit Config]** soft key to return to clinical operation.

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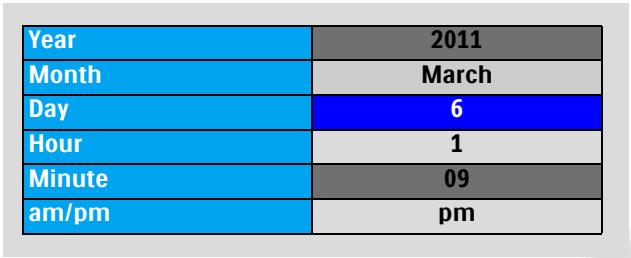
Setting Date and Time

To modify the date and time from Configuration:

1. Once in Configuration Mode, press the Menu Select button.
2. Select **Date/Time** and press the Menu Select button. The Configuration Date/Time screen appears. See Figure 69.

Figure 69 **Configuring Date and Time**



3. Using the Navigation buttons, select the entry you want to change and press the Menu Select button.
4. Adjust the value (see "Adjusting Numeric Values" on page 32). Press the Menu Select button to accept your change.
5. Select another value for modification or press the **[Main Config]** soft key to save changes and return to the main Configuration screen.

NOTE: To adjust the format of the date and time, you need to enter the Configuration Mode password. See "Changing Settings" on page 137.

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Changing Settings

To change default settings in Configuration Mode:

1. Press the **[Change Config]** soft key.
2. Enter the configuration password:
   a. Using the Navigation buttons, select the first number and press the Menu Select button.
   b. Use the Navigation and Menu Select buttons to enter the remaining numbers in the password.
   c. When finished, select **Done** and press the Menu Select button.
3. Press the Menu Select button and use the Navigation buttons to select the parameter to be changed. Then press the Menu Select button.
4. Select the sub-menu you want to change, then press the Menu Select button.
5. Select the new default option. Press the Menu Select button to select the highlighted choice.
6. Use the **[Next Screen]** soft key to advance to the next parameter and repeat steps 4-6 to make additional changes.
7. Once the desired changes have been made, press the **[Main Config]** soft key to return to the Configuration Main screen. Press the **[Save Changes]** soft key to save the new configuration.
   - Pressing the **[Cancel Changes]** soft key returns you to the previous settings.
   - Pressing the **[Factory Defaults]** soft key resets all settings to factory defaults.
8. Press the **[Exit Config]** soft key to return to normal operating mode. If you press **[Exit Config]** before saving changes, you are asked if you want to exit without saving the changes.
   - If you want to save the changes, select **No**, press the Menu Select button, press the **[Save Changes]** soft key and then exit Configuration Mode.
   - If you do not want to save the configuration, select **Yes** and press the Menu Select button to exit Configuration Mode.

Exporting Settings

To export configuration settings to a USB drive:

1. Confirm you have a USB drive inserted into the USB port and you are in Configuration Mode.
2. Press the **[Export]** soft key.
3. The HeartStart XL+ copies your current configuration to the USB drive.

NOTE: If you already have a configuration stored on the USB drive, exporting another to the USB drive overwrites the one already on the drive.

Importing Settings

To import configuration settings from a USB drive:

1. Once in Configuration Mode, insert the USB drive with the saved settings into the USB port.
2. Press the **[Change Config]** soft key and enter the Configuration password.
3. Press the **[Import]** soft key. The HeartStart XL+ copies the current configuration from the USB drive.
4. Make any device-specific configuration changes.
5. Press the **[Save Changes]** soft key.

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Printing Settings

To print the configuration settings:

1. In Configuration Mode, press the Menu Select button.
2. Using the Navigation buttons, select **Print Configuration**.
3. Press the Menu Select button to print the report. See Figure 70.

NOTE: To stop printing, press the Print button.

Figure 70 **Sample Configuration Report**

Configuration Report

	Options	Date/Time format Settings	General Settings
(Current Date)	(All installed options on your HeartStart XL+ are listed here, including field upgrade kits and factory installed options.)	Date Format: (setting)	Patient Category: (setting)
HeartStart XL+		Time Format: (setting)	Alarm tone: (setting)
S/N: (Device Serial Number)		Auto Correct for Daylight Savings Time: (setting)	Alarm Pause Time: (setting)
(Software revision)		DST Start: (setting)	Alarm Volume: (setting)
		DST End: (setting)	Minimum Alarm Volume: (setting)
		DST Offset: (setting)	Voice Volume: (setting)
			QRS Volume: (setting)
			Units Display: (setting)
			Export Without Patient Info: (setting)

Following the General Settings listing, the Configuration Report continues to list the configured device settings in the order they are listed in Configuration Mode. See "Configurable Parameters" on page 139.

NOTE: Configuration setting information appearing in parenthesis in Figure 70 are replaced by the current setting when an actual Configuration Report is printed. For example: (Current Date) is replaced with the date the report is printed.

Restoring Default Settings

To return all configuration settings to those originally set during manufacturing:

1. Press the **[Change Config]** soft key.
2. Enter the Configuration Password.
3. Press the **[Factory Defaults]** soft key.
4. Once you are prompted to save changes, select **Yes** and press the Menu Select button.

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Configurable Parameters

The following tables list configurable parameters for the HeartStart XL+. Default settings are in bold type. Values are adjusted in increments of 1 unless otherwise stated.

Table 28 **Date/Time Format**

Parameter	Description	Setting Choices	
Time Format	Defines the time format.	12-Hour, **24-Hour**	
Date Format	Defines the date format.	**DD Mon YYYY**, YYYY-MM-DD (D = Day, M=Month, Y=Year)	
Auto Daylight Savings Time (DST)	Defines whether or not your device auto corrects for Daylight Savings Time.	Yes, **No**	
DST offset	Defines the hour and minute time shift during DST.	±2 hours, **+ 1 hour** adjusted in 30 minutes increments	
Month	Defines the month DST begins/ends.	**DST Start Settings**	**DST End Settings**
		Any of the 12 months, **March**	Any of the 12 months, **November**
Week of Month	Defines the week DST begins/ends.	First, **Second**, Third, Fourth, Last	**First**, Second, Third, Fourth, Last
Day of Week	Defines the day DST begins/ends.	Any day of the week, **Sunday**	
Hour	Defines the hour DST begins/end.	00-23 (if 24-hour format); 01-12 (if 12-hour format), **2**	
Minute	Defines the minute DST begins/end.	00-59, **00**	
am/pm	Defines the 12-hour segment DST begins/end.	**am**, pm	

NOTE: Daylight Saving Time changes occur when the next event is started. The time does not change in the middle of an event that crosses over the DST change.

Table 29 **General Settings**

Parameter	Description	Setting Choices
Patient Category	Selects the default patient category.	**Adult**, Infant/Child
Alarm Tone	Defines either traditional Philips or IEC standard alarm tones.	**Philips**, IEC
Alarm Pause Time	Defines the interval of time during which alarms are paused after the Alarm button is pressed.	1 min, **2 min**, 3 min, 5 min, 10 min, indefinite
Alarm Volume	Defines alarm volume level.	Very Soft, Soft, **Medium**, Loud, Very Loud

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Table 29 **General Settings *(Continued)***

Parameter	Description	Setting Choices
Minimum Alarm Volume	Defines the minimum audible alarm level available within use.	Very Soft, **Soft**, Medium, Loud, Very Loud
Voice Volume	Defines voice prompt levels.	Very Soft, Soft, **Medium**, Loud, Very Loud
QRS Volume	Defines the volume level of audible beeps with each QRS complex detected.	Off, **Very Soft,** Soft, Medium, Loud, Very Loud
Units Display	Defines if parameter values are displayed with or without the corresponding measurement units.	**On**, Off
Export Without Patient Info	Defines if when exporting clinical data a prompt is displayed asking if you want to de-identify the data.	Prompt, **Disabled**

NOTE: The list of available alarm volumes is limited so that no choice less that the current setting for Minimum Alarm Volume is presented. If the Minimum Alarm Volume is changed and the current alarm volume is quieter than the new Minimum Alarm Volume, the current alarm volume is changed to match the setting for the Minimum Alarm Volume.

Table 30 **Heart Rate/ECG Settings**

Parameter	Description	Setting Choices
Color	Selects the HR/ECG color.	Red, Yellow, Blue, **Green**, Cyan, Magenta, White
Auto Gain	Determines whether ECG size is automatically adjusted to the maximum wave size without clipping the wave sector. If auto-gain is off, the gain is set to x1 (10mm/mV).	On, **Off**
NOTE: Adjusting the ECG wave size on the display does not affect the ECG signal which is used for arrhythmia analysis.		
AC Line Filter	Selects the setting used to filter out AC line noise from ECG data. Adjust setting to the power frequency of your country.	50 Hz, **60 Hz**
ECG Bandwidth For Display	Selects the display filter frequency for 3/5-Lead ECG cable.	**0.15-40 Hz**, 0.05-40 Hz
ECG Bandwidth For Printer	Selects the display filter frequency for the attached therapy cable or 3/5-Lead ECG cable.	**0.05-150 Hz Diagnostic**, 0.15-40 Hz, 0.05-40 Hz

Table 30 **Heart Rate/ECG Settings *(Continued)***

Parameter	Description	Setting Choices
NOTE: If the ECG source is pads or paddles, 0.15-40 Hz is used regardless of the configuration settings.		
ECG Electrode Labels	Selects the electrode label format. AAMI: RA, LA, LL, RL, V; IEC: R, L, F, N, C.	**AAMI**, IEC
HR/Pulse High Limit	Selects the default High Alarm Limit for the HR derived from the ECG and the pulse derived from SpO_2.	Adult: 35-300, **120** bpm Infant/Child: 35-300, **160** bpm adjusted in increments of 5
HR/Pulse Low Limit	Selects the default Low Alarm Limit for the HR derived from the ECG and the pulse derived from SpO_2.	Adult: 30-295, **50** bpm Infant/Child: 30-295, **80** bpm adjusted in increments of 5
VTach HR Limit	Selects the VTach heart rate limit.	Adult: 95-150, **100** bpm Infant/Child: 95-150, **120** bpm adjusted in increments of 5
VTach Run Limit	Selects the VTach run limit.	Adult: 3-20, **5** Infant/Child: 3-20, **5**
PVC Rate Limit	Selects the PVC limit.	Adult: 1-99, **10** Infant/Child: 1-99, **5**

Table 31 **NBP Settings**

Parameter	Description	Setting Choices
Color	Selects the NBP color.	Red, Yellow, Blue, Green, Cyan, Magenta, **White**
Unit	Selects the measurements units.	**mmHg**, kPa
NBP Frequency	Selects the frequency for NBP measurement: manual or automatic on a selected schedule.	**Manual**, q1, q2.5, q5, q10, q15, q30, q60, q120
NBP Alarm Source	Selects the alarm source.	**Systolic**, Diastolic, Mean
Systolic High Limit	Selects the high limit alarm value when systolic is the selected alarm source.	Adult: 45-260, **160** (mmHg); 6-35, **21** (kPa) Infant/Child: 45-160, **120** (mmHg); 6-22, **16** (kPa)
Systolic Low Limit	Selects the low limit alarm value when systolic is the selected alarm source.	Adult: 40-255, **90** (mmHg); 5-34, **12** (kPa) Infant/Child: 40-155, **70** (mmHg); 5-21, **9** (kPa)

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Table 31 **NBP Settings *(Continued)***

Parameter	Description	Setting Choices
Diastolic High Limit	Selects the high limit alarm value when diastolic is the selected alarm source.	Adult: 25-200, **90** (mmHg); 3-27, **12** (kPa) Infant/Child: 25-120, **70** (mmHg); 3-16, **9** (kPa)
Diastolic Low Limit	Selects the low limit alarm value when diastolic is the selected alarm source.	Adult: 20-195, **50** (mmHg); 2-26, 7 (kPa) Infant/Child: 20-115, **40** (mmHg); 2-15, **5** (kPa)
Mean High Limit	Selects the high limit alarm value when mean is the selected alarm source.	Adult: 30-220, **110** (mmHg); 4-30, **15** (kPa) Infant/Child: 30-135, **90** (mmHg); 4-18, **12** (kPa)
Mean Low Limit	Selects the low limit alarm value when mean is the selected alarm source.	Adult: 25-215, **60** (mmHg); 3-29, **8** (kPa) Infant/Child: 25-130, **50** (mmHg); 3-17, 7 (kPa)

Table 32 **SpO_2 Settings**

Parameter	Description	Setting Choices
Color	Selects the SpO_2 color.	Red, Yellow, Blue, Green, **Cyan**, Magenta, White
SpO_2 High limit	Selects the high alarm limit value.	Adult: 51-100, **100** % Infant/Child: 51-100, **100** %
SpO_2 Low Limit	Selects the low alarm limit value.	Adult: 50-99, **90** % Infant/Child: 50-99, **90** %
SpO_2 Desat Limit	Selects the extreme low limit alarm value.	Adult: 50-SpO_2 Low Limit, **80** % Infant/Child: 30-SpO_2 Low Limit **80** %

Table 33 **Wave Settings**

Parameter	Description	Setting Choices
Wave 1	Selects the waveform displayed in Wave Sector 1.	Pads, I, **II**, III, aVR, aVL, aVF, V

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Table 33 **Wave Settings *(Continued)***

Parameter	Description	Setting Choices
NOTE: The default for Wave Sector 1 cannot be set to Paddles.		
Wave 2	Selects the waveform displayed in Wave Sector 2.	Pads/Paddles, I, II, III, aVR, aVL, aVF, V, **Cascade**, Annotated ECG, Pleth, None
Wave 3	Selects the waveform displayed in Wave Sector 3.	Pads/Paddles, I, II, III, aVR, aVL, aVF, V, Pleth, None. **Default:** Pleth if you have the SpO_2 option installed; None if you do not.

Table 34 **Defib/Sync/AED Settings**

Parameter	Description	Setting Choices
1-10 Joules Default	Defines the device's low-energy setting.	1, 2, 3, 4, 5, **6**, 7, 8, 9, 10 J
Remain in Sync Mode after shock	Defines if the device remains in Sync Mode after a delivered shock.	**Yes**, No
Time to Auto Disarm	Defines the amount of time the device remains charged if a shock has not been delivered. Applies to Manual Defibrillation and Sync modes only.	**30**, 60, 90 sec
Shock Series	Defines the number of shocks in a shock series.	**1**, 2, 3, 4
Shock Protocol Timeout	Defines the time interval used to determine if a shock should be counted as part of a shock series.	**1 min**, 2 min, Indefinite
AED Only		
Voice Prompts	Defines the level of detail in AED Mode voice prompts.	Long, **Short**
NSA Action	Defines what the device does after a No Shock Advised decision.	NSA Monitor, **NSA CPR** (NSA Monitor allows you to initiate background shock advisory analysis; NSA CPR prompts you to initiate a CPR Pause period, if needed.)
NSA Monitor Prompt Interval	Defines the interval for patient care prompts in NSA Monitor following a No Shock Advised decision.	**1**, 2, 3, Infinite (no prompts at all) min
SpO_2 Monitoring	Defines whether SpO_2 monitoring is available in AED Mode.	Enabled, **Disabled**

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Table 34 **Defib/Sync/AED Settings *(Continued)***

Parameter	Description	Setting Choices
Adult 1st Shock Energy Dose	Defines the energy dose for the first shock in a series in AED Mode.	All energy settings ≥ 100J, **150**
Adult 2nd Shock Energy Dose	Defines the energy dose for the second shock in a series in AED Mode.	All energy settings ≥ the first configured shock in the series, **150**
Adult 3rd Shock Energy Dose	Defines the energy dose for the third and subsequent shocks in a series in AED Mode.	All energy settings ≥ the second configured shock in the series, **150**

Table 35 **CPR Settings**

Parameter	Description	Setting Choices
CPR Time	Defines the length of the CPR administration interval.	1, 1.5, **2**, 2.5, 3 min

Table 36 **Pacer Settings**

Parameter	Description	Setting Choices
Default Pacer Rate	Defines the delivery rate of paced pulses.	30-180, **70** pulses per minute Adjusted in increments of 10
Pace Pulse Duration	Defines the paced pulse duration.	**20**, 40 msec
Default Pacer Output	Defines the pacer output default setting at which paced pulses are delivered.	If Paced Pulse duration is 20 msec: 10-200, **30** mA If Paced Pulse duration is 40 msec: 10-140, **30** mA

Table 37 **Mark Event Settings**

Parameter	Description	Setting Choices
Mark Event 1	Defines the first mark event menu choice.	**IV Access**
Mark Event 2	Defines the second mark event menu choice.	**Epinephrine**
Mark Event 3	Defines the third mark event menu choice.	**Amiodarone**
Mark Event 4	Defines the fourth mark event menu choice.	**Atropine**
Mark Event 5	Defines the fifth mark event menu choice.	**Morphine**
Mark Event 6	Defines the sixth mark event menu choice.	**Nitroglycerin**

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Table 37 **Mark Event Settings *(Continued)***

Parameter	Description	Setting Choices
Mark Event 7	Defines the seventh mark event menu choice.	**Aspirin**
Mark Event 8	Defines the eighth mark event menu choice.	**Other**

NOTE: There is a 20 character limit when defining Mark Events. See "Mark Events" on page 134.

Table 38 **Printing Settings**

Parameter	Description	Setting Choices
Print On Alarm	Defines the type of alarms that automatically print a strip.	**High**, High/Medium
Print On Charge	Defines if a continuous strip is printed when the device is charged.	**Yes**, No
Print On Shock	Defines if a continuous strip is printed when a shock is delivered or when a shock is attempted but not delivered.	**Yes**, No
Print On Mark	Defines if a continuous strip is printed when the Mark Event button is pressed.	**Yes**, No
Printer Delay	Defines whether printed strips include an additional 10 seconds of information which occurred just prior to initiating the print.	0 Sec, **10 sec**
Event Summary Report	Defines the information contained in an Event Summary. Short includes a log of events and vitals; Long adds waveforms.	Short, **Long**
Auto Print OpCheck Report	Defines if a OpCheck report is automatically printed upon the completion of an Operational Check.	**Yes**, No
Weekly Tests in Auto Test Summary	Provides a numerical value indicating the number of weekly tests in the auto text summary.	No default

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NOTES

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Operational and Shift Checks

The HeartStart XL+ performs several automated tests to make sure it is ready for use (see "Automated Tests" on page 164). Two important checks you perform to supplement the automated tests are Operational Check and Shift Check. This chapter details both of these important tasks.

Shift Check

In order to ensure defibrillators are ready when needed, the American Heart Association (AHA) recommends that users complete a checklist, often referred to as a Shift Check, at the beginning of each change in personnel. These checks are performed in addition to the periodic checks performed by your facility's biomedical or clinical engineering team. The activities on this checklist include verifying that the appropriate supplies and accessories are present, the device is plugged in and has sufficient battery power, and the device is ready for use. Philips Healthcare supports the AHA checklist recommendations and has provided a Shift Checklist document with the device and published a copy in this book. See "HeartStart XL+ Shift Checklist" on page 149.)

As part of the Shift Check, you must verify the device's ability to deliver defibrillation therapy once a week by performing a shock test. You can complete this important requirement by performing one of the following:

- Weekly Shock Test (see "Weekly Shock Test" on page 148)
- Operational Check (see "Operational Check" on page 151)

WARNING: When performing an Operational Check or Weekly Shock Test, be sure to disconnect the ECG leads set from the cable and confirm the HeartStart XL+ is not connected to a patient.

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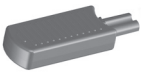
Weekly Shock Test

A Weekly Shock Test is performed using either a test plug, a test load or paddles. The Weekly Shock Test process and results differ depending which way you choose to perform the test. See chart below.

To perform the Weekly Shock Test:

	If you are using pads with a test load: 	**If you are using pads with a test plug:**	**If you are using paddles:**
1	Connect the Therapy cable to defibrillator and test load to the end of the Therapy cable.	Connect the Therapy cable to defibrillator and test plug to the end of the Therapy cable.	Make sure the paddles and the paddle tray are thoroughly clean and there is no debris or residue (including all conductive material) on the electrode surfaces of the paddles and tray. Secure the paddles in the tray and confirm the Patient Contact Indicator (PCI) LEDs are not lit. If the LEDs are lit, adjust the paddles in the tray. If the LEDs continue to light, clean both the adult and infant paddle electrode surfaces.
2	Turn the device on by turning the Therapy knob to 150J.		
3	Press the Charge button on the front panel. If it becomes necessary to disarm the defibrillator, press **[Cancel Charge].**		Press the Charge button on the paddles sitting in the tray. If it becomes necessary to disarm the defibrillator, press **[Cancel Charge].**
4	A strip prints, if configured to do so. If the strip does not print immediately, press the Print button.		A strip prints, if configured to do so. If the strip does not print immediately, press the Print button.
5	Press the Shock button on the HeartStart XL+.		Simultaneously press the Shock buttons located on the paddles.
6	Confirm the printed strip indicates **Test Passed** and the energy delivered is150J, ±15J (135J to 165J). If not, confirm you did the test properly before taking the device out of use and calling for service.	Confirm that you hear a "Shock Cancelled" audio message, see a **Shock Aborted** alarm on the display and the printed strip indicates **Test Passed**. If not, confirm you did the test properly before taking the device out of use and calling for service.	Confirm the printed strip indicates the defibrillator test passed and the energy delivered is150J, ±15J (135J to 165J). If not, confirm you did the test properly before taking the device out of use and calling for service.
7	Detach test load/plug from the Therapy cable so your device is ready for use when needed. Do not leave the test load/plug attached to the Therapy cable. If you use preconnected pads, reattach them. Test complete.		Test complete.

NOTES: For more information on the differences between a test load and test plug, see "Test Plug & Test Load" on page 19.

If you perform a Weekly Shock Test with internal paddles and corresponding test equipment, the HeartStart XL+ must be set to 50J. Refer to the test equipment manufacturer's instructions for information on interpreting results of the test.

If you use external paddles and have the Pacing option, you should confirm pads functionality by performing an Operational Check.

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HeartStart XL+ Shift Checklist

Inspect the HeartStart XL+, accessories and supplies at the change of every shift per AHA Guidelines. Place a checkmark in the box as you check each item in the list below. Place a dash mark or other symbol if the entry is not applicable. Initial the list to indicate the check was performed for that shift.

Device Name or Serial Number:							**Unit or Department:**											
Date:																		
Shift	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
RFU Indicator (Hourglass) If blinking red X – Plug into AC power or insert charged battery. **If solid red X** – Insert charged battery or plug in AC power. If condition persists, call for service.																		
Case – clean, free from spills and objects.																		
Cable/connectors – present and inspected.																		
Paddles/Therapy Cable – present, inspected and paddles release from tray.																		
Multifunction pads – present, sufficient supply; check expiration date.																		
Monitoring electrodes –present, sufficient supply; check expiration date.																		
Charged batteries – one in device, spares. Check battery gauge.																		
AC power cord – plugged in, green light on.																		
Printer paper – present, sufficient supply.																		
USB drive – present.																		
SpO_2 sensors – if option is installed) present, sufficient supply.																		
NBP cuffs/tubing – (if option is installed) present, sufficient supply.																		
Other ancillary supplies test plug/test load, gel, scissors, razor) – present, sufficient supply.																		
Initials:																		

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Shift Checklist (Page 2) HeartStart XL+ Weekly Shock Test

Do one of the following checks at least once a week to verify the ability to deliver defibrillation therapy:

☐ Operational Check (See the *HeartStart XL+ Instructions for Use* for details.)

☐ Deliver a 150J shock into a test plug/load (if using multifunction electrode pads) or the paddle tray (if using paddles).

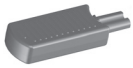
☐ Weekly Shock test is not applicable for this Shift Check.

Check off which option you selected and sign/date below.

Signature:	Date:

NOTE: Test reusable sterilizable paddles (internal or external) prior to each use. See the *Sterilizable Defibrillator Paddles Instructions for Use*.

To perform the Weekly Shock Test:

	If you are using pads with a test load: 	**If you are using pads with a test plug:**	**If you are using paddles:**
1	Connect the Therapy cable to the defibrillator and test load to the end of the Therapy cable.	Connect the Therapy cable to the defibrillator and test plug to the end of the Therapy cable.	Make sure the paddles and the paddle tray are thoroughly clean and there is no debris or residue (including all conductive material) on the electrode surfaces of the paddles and tray. Secure paddles in tray and confirm Patient Contact Indicator (PCI) LEDs are not lit. If the LEDs are lit, adjust paddles in tray. If the LEDs continue to light, clean both the adult and infant paddle electrode surfaces.
2	Turn the device on by turning the Therapy knob to 150J.		
3	Press the Charge button on the front panel. If it becomes necessary to disarm the defibrillator, press **[Cancel Charge].**		Press the Charge button on the paddles sitting in the tray. If it becomes necessary to disarm the defibrillator, press **[Cancel Charge].**
4	A strip prints, if configured to do so. If the strip does not print immediately, press the Print button.		A strip prints, if configured to do so. If the strip does not print immediately, press the Print button.
5	Press the Shock button on the HeartStart XL+.		Simultaneously press the Shock buttons located on the paddles.
6	Confirm the printed strip indicates **Test Passed** and the energy delivered is150J, ±15J (135J to 165J). If not, confirm you did the test properly before taking the device out of use and calling for service.	Confirm that you hear a "Shock Cancelled" audio message, see a **Shock Aborted** alarm on the display and the printed strip indicates **Test Passed**. If not, confirm you did the test properly before taking the device out of use and calling for service.	Confirm the printed strip indicates the defibrillator test passed and the energy delivered is150J, ±15J (135J to 165J). If not, confirm you did the test properly before taking the device out of use and calling for service.
7	Detach test load/plug from the Therapy cable so your device is ready for use when needed. Do not leave the test load/plug attached to the Therapy cable. If you use preconnected pads, reattach them. Test complete.		Test complete.

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Operational Check

Operational Checks supplement automated tests by verifying therapy cables, the ECG cable, paddles, audio, charge and shock buttons, and the ability to deliver defibrillation and pacing therapy. Operational Check also notifies you if the battery needs calibration, checks the SpO_2 and NBP modules and printer.

Operational Checks should be performed at regularly scheduled intervals to supplement the hourly, daily and weekly tests the HeartStart XL+ performs automatically.

From Operational Check you can also print Automated Test and Operational Check results.

WARNING: When performing an Operational Check or Weekly Shock Test, be sure to disconnect the ECG leads set from the cable and confirm the HeartStart XL+ is not connected to a patient.

NOTES: Do not run Operational Check with internal paddles attached. Perform a Weekly Shock Test to test internal paddles.

To confirm the ECG cable used during an event is functioning properly, use that same cable during Operational Check.

If the HeartStart XL+ is equipped with multifunction electrode pads only and does not have a paddle tray, you cannot test paddles during an Operational Check. To test paddles, you must have a simulator to deliver the shock into. Run the Weekly Shock Test, delivering the shock into the simulator.

To enter Operational Check:

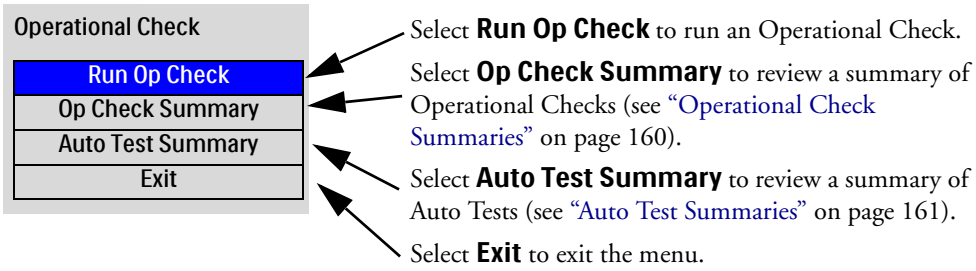
1 Turn the Therapy knob to **Monitor**.

2 Press the Menu Select button.

3 Using the Navigation buttons, select **Other** and press the Menu Select button.

4 Select **Operational Check** and press the Menu Select button. See Figure 71 for Operational Check menu options.

Figure 71 **Operational Check**


Operational Check
Run Op Check
Op Check Summary
Auto Test Summary
Exit
Select Run Op Check to run an Operational Check.
Select Op Check Summary to review a summary of Operational Checks (see "Operational Check Summaries" on page 160).
Select Auto Test Summary to review a summary of Auto Tests (see "Auto Test Summaries" on page 161).
Select Exit to exit the menu.

5 Confirm your exit from a clinical mode. Select Yes and press the Menu Select button.

The following tests are performed during an Operational Check (see "Operational Check Tests and Results" on page 155):

- General System
- Sync button
- SpO_2
- Printer
- Therapy Knob
- Therapy
- NBP
- Battery
- Charge button
- Leads ECG
- Shock button
- Audio
- Leads ECG rerun (if necessary)
- Pads/Paddles ECG

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Performing an Operational Check

Prior to performing an Operational Check:

If you use external paddles: Make sure the paddles are connected to the device, paddles and the paddle tray are thoroughly clean and there is no debris or residue (including all conductive material) on the electrode surfaces of the paddles and tray. Secure the paddles in the tray and confirm the Patient Contact Indicator (PCI) LEDs are not lit. If the LEDs are lit, adjust the paddles in the tray. If the LEDs remain lit, clean both the adult and infant/child paddle electrode surfaces.

If you use multifunction electrode pads: Make sure the pads therapy cable is plugged into the defibrillator test plug or test load.

To begin an Operational Check:

1. Confirm your device has a charged battery and an ECG cable connected (but not connected to a patient or lead sets).
2. Turn the Therapy knob to **Monitor**.
3. Press the Menu Select button.
4. Using the Navigation buttons, select **Other** and press the Menu Select button.
5. Select **Operational Check** and press the Menu Select button.
6. Select **Run Op Check** and press the Menu Select button. The message **Leaving clinical mode. Patient monitoring will be turned off.** appears.
7. Select **Yes** if you wish to continue with an Operational Check. Select **No** to return to Monitor Mode. Press the Menu Select button to confirm your choice.
8. If you selected **Yes**, the HeartStart XL+ displays the Operational Check Screen (see Figure 72) and starts the Operational Check automatically.

NOTE: If the HeartStart XL+ is not set up correctly, the display prompts you to make the required changes for a successful Operational Check (see Figure 72). The Therapy knob must be set to 170J to begin Operational Check. Once the check begins, set the knob back to 150J when prompted to do so. Operational Check runs automatically. If you choose to proceed without setting up properly, the Operational Check may fail.

9. During the Operational Check, when a response is required, use the Navigation buttons to select your answer and the Menu Select button to confirm your choice. As each test runs, the name of the test appears highlighted on the display with the message **In Progress**. See Figure 73.

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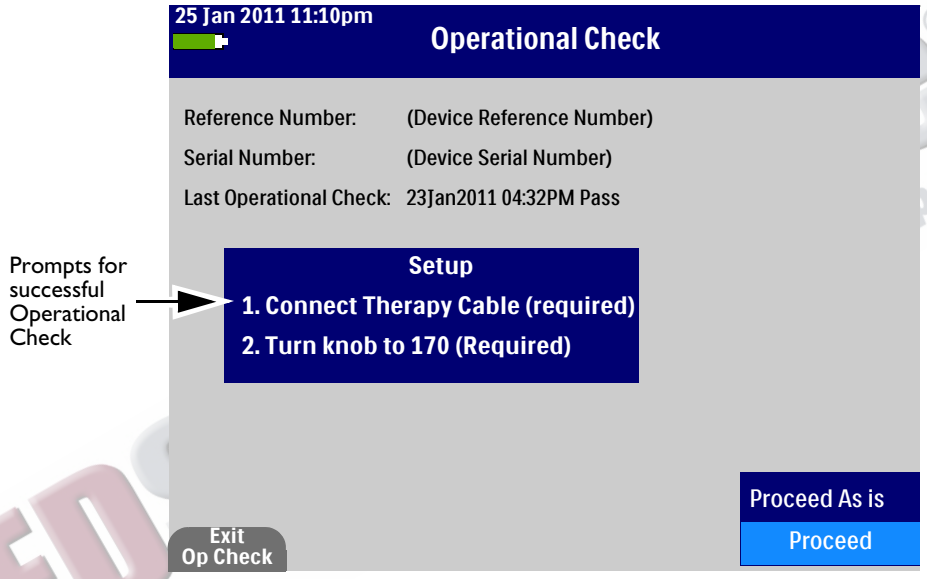
NOTE: Once you have pressed the Sync button, you can leave the HeartStart XL+ unattended as Operational Check completes its process. If you cancel the Operational Check before it completes all tasks, there is no record of the check in the Operational Check Summary.

10 After the automated part of Operational Check concludes, an Operational Check Report is printed (see "Printing Operational Check Results" on page 158).

WARNING: When the shock button is pressed during Operational Check, energy is delivered through the pads/paddles into the defibrillator test plug/test load or paddles pockets. Make sure that the test plug or test load is connected or that the paddles are seated in the holders properly.

Figure 72 **Operational Check Setup Screen**

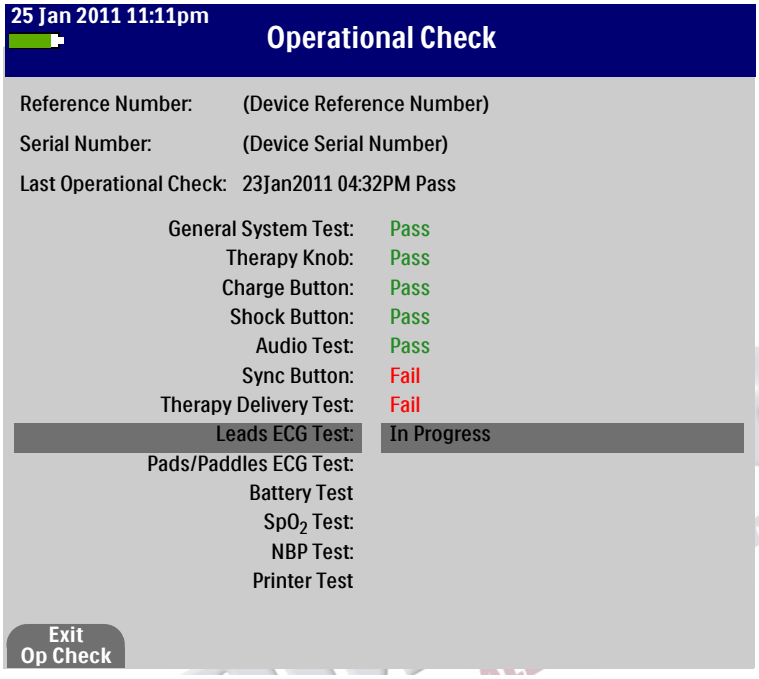


NOTE: It is important to complete all instructions listed on the Setup screen in order to successfully complete an Operational Check. Approximately 10 seconds after entering Operational Check, a **Proceed As Is** prompt appears in the lower right corner of the display. This prompt allows you to continue with the Operational Check if the device is not responding to actions you have taken during Setup. Selecting **Proceed As Is** while there are still required items listed in the setup instructions causes Operational Check failures.

Operational Check Results

Each test that makes up the Operational Check either passes or fails (see Figure 73 for an example).

Figure 73 **Operational Check In Process Screen**



NOTE: Text Data appearing in parenthesis in Figures 72 and 73 are replaced by device information in an actual screen. For example: (Device Serial Number) is replaced with the device's serial number.

Once the Operational Check is completed, a summary note appears in the middle of the display. To remove the message from the screen press the **[Hide Messages]** soft key. To bring the messages back, hit the **[Show Messages]** soft key.

If you fail an Operational Check for a therapy-related problem (for example a failed Therapy knob or button), therapy is disabled. You receive messages on the display and the RFU indicator is a solid Red X. After exiting Operational Check, the HeartStart XL+ restarts with therapy disabled.

NOTE: When exiting Operational Check, if the failure is related to the Therapy knob, you restart and remain in Monitor Mode regardless of the knob's position on the dial. If the device does not turn off with the knob in the **Off** position, take it out of use and call for service.

The failure may have been caused by an improperly performed Operational Check. To clear the failed Operational Check, successfully perform a proper Operational Check. If the device continues to fail the Operational Check and you have confirmed you are performing the Operational Check properly, take the device out of use and call for service.

Leads ECG Test Rerun

If the Leads ECG test fails, upon the completion of Operational Check, the HeartStart XL+ prompts you with the message **Leads ECG Test Failed With Cable. Disconnect the ECG Cable to rerun test without the cable**. As soon as you remove the ECG cable, the device reruns Operational Check to check if the problem is in the device itself. If you do not wish to rerun Operational Check, press the Menu Select button to proceed without rerunning the test.

Table 39 **Operational Check Tests and Results**

Test	Device Prompts	User Actions	Results	What to do if test doesn't pass
General System - tests internal clock battery, power supply and internal memory	None	None	Pass - All tested systems are functioning properly. Fail - One or more of the tested systems is not functioning properly.	Take the device out of use and call for service.
Therapy Knob - tests if the Therapy knob is set to 170J and functioning properly	None	None	Pass - The Therapy knob is set to 170J and functioning properly. Fail - The Therapy knob is not set to 170J. Fail - The Therapy knob is not functioning properly. NOTE: When the Therapy knob fails, you restart and remain in Monitor Mode regardless of the knob's position on the dial.	Confirm that the Therapy knob is set to 170J and repeat Operational Check. If the test continues to fail, take the device out of use and call for service.
Charge button - tests the Charge button's functionality	Depending on the cable connected: Therapy cable: You are prompted to **Verify Test Load Is Attached. Press the Charge Button.**	Move Therapy knob to 150. Confirm test load/defibrillator test plug is attached and press the Charge button.	Pass - Charge button passed. Fail - Charge button is not functioning. Fail - You used the Menu Select button to charge.	Repeat the test and make sure you press the Charge button. If Operational Check continues to fail, take the device out of use and call for service.
	External Paddles: You are prompted to **Verify Paddles Are in Holder. Press the Charge Button.**	Move Therapy knob to 150. Confirm the paddles are seated in their pockets and press the Charge button.		
	If the device does not detect a pressed Charge button within 10 seconds, you are prompted to use the Menu Select button to charge.			

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Table 39 **Operational Check Tests and Results *(Continued)***

Test	Device Prompts	User Actions	Results	What to do if test doesn't pass
Shock button - tests the Shock button's functionality	Once charged, the device prompts you to **Press Shock** or **Press Both Shock Buttons on Paddles** If the device does not detect a pressed Shock button within 10 seconds, you are prompted to use the Menu Select button to shock. NOTE: The device auto disarms when reaching the time specified in Configuration. A **Defib Disarmed** message is displayed.	Press the Shock button on the device or paddles.	Pass - Shock button passed Fail - Shock button is not functioning Fail - You used the Menu Select button to shock Fail - Device disarmed automatically	Repeat Operational Check and make sure you press the Shock button before the defibrillator disarms. If Operational Check continues to fail, take the device out of use and call for service.
Audio - tests the speaker system	The device announces: **Shock Delivered** or **No Shock Delivered**	Using the Navigation buttons, select **Yes** or **No**. Press the Menu Select button.	Pass - You responded that you heard the audio test prompt. Fail - You responded that you did not hear the audio test prompt.	Repeat Operational Check. If it continues to fail, take the device out of use and call for service.
Sync button - tests the Sync button's functionality	The device prompts you to **Press and Release Sync Button** If the device does not detect a pressed Sync button within 10 seconds, you are prompted to use the Menu Select button to select OK.	Press and release the Sync button	Pass - Sync button passed. Fail - Sync button is not functioning.	Repeat Operational Check and make sure you press the Sync button. If it continues to fail, take the device out of use and call for service.
Therapy Delivery - tests defibrillation and pacing circuitry and delivers a shock	None	None	Pass - Therapy Delivery test passed with the specified cable type connected. Fail - Therapy Delivery test failed with the specified cable type connected.	Repeat Operational Check using a different cable. Passing a second time indicates the previous cable is defective and should be removed from service. If it continues to fail, take the device out of use and call for service.
Leads ECG - tests leads ECG acquisition and the ECG cable	None	None	Pass - Tested system is functioning properly. Fail - Tested system is not functioning properly.	Rerun the Leads ECG test when prompted at the end of Operational Check. If it continues to fail, take the device out of use and call for service.

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Table 39 **Operational Check Tests and Results *(Continued)***

Test	Device Prompts	User Actions	Results	What to do if test doesn't pass
Pads/Paddles ECG - Checks ECG acquisition with pads/paddles	None	None	Pass/cable type - ECG acquisition and the cable are both functioning. Pass/No Cable - ECG acquisition is functioning; cable not tested. Fail/Cable type - ECG acquisition and/or the cable specified are not functioning.	If Operational Check fails with a cable connected, replace the cable and run the test again. If it continues to fail take the device out of use and call for service.
Battery - tests battery capacity and calibration status	None	None	None - there is no battery in the slot. Pass - Battery is functioning properly and charged. Pass/Low Battery. Fail/Calibration is required.	 Charge battery. Calibrate battery.
SpO_2 - tests internal SpO_2 functionality (cable is not tested)	None	None	Pass - SpO_2 passed test. Fail - SpO_2 failed test.	Call for service to repair the SpO_2 module. If SpO_2 monitoring is essential to patient care, take the device out of use.
NBP- tests internal NBP functionality	None	None	Pass - NBP passed test. Fail - NBP failed test. Calibration Overdue.	Calibrate NBP module if calibration is overdue. If a failure is detected, call for service. If NBP monitoring is essential to patient care, take the device out of use.
Printer - runs a printer self test	None	None	Pass - Printer passed its self-test. Fail - Printer failed its self-test.	Call for service.

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Printing Operational Check Results

If configured to do so (see "Printing Settings" on page 145), the Operational Check Report (see "Sample Operational Check Report" on page 159) automatically prints out after an Operational Check is completed. To manually print, press the Menu Select button and select **Print**.

The first part of printed Operational Check lists test results. The second part lists checks performed by the user.

User Checks

Once the Operational Check Report prints, perform the following manual checks to complete the Operational Check.

- Defibrillator Inspection – Make sure the HeartStart XL+ is clean (including the surfaces of the paddles and paddle trays), clear of objects and has no visible signs of damage.
- ECG Cables/Connectors/Paddles/Pads/Monitoring Electrodes – Make sure there are no visible cracks, broken wires or other visible signs of damage. Make sure all the connections are secure. Check expiration date and quantity of pads and monitoring electrodes.
- Charged Battery – Make sure a charged battery is installed in the HeartStart XL+. Another charged battery should be available or charging. Confirm the battery has no visible signs of damage.
- AC Power Cord – Check the AC power source by connecting the AC power cord to the HeartStart XL+ and plug it into a power outlet. Then verify that the external power indicator on the front panel is lit.
- Printer Paper – Make sure the printer has sufficient paper and is printing properly.
- SpO_2 Sensor – Inspect the sensor and cable for visible signs of damage.
- NBP Cuffs and Tubing – Inspect the pressure cuffs and tubing for visible signs of damage.
- USB Connector – Inspect the port for visible signs of debris or damage.

NOTES: Upon completing the Operational Check and returning to a clinical mode, all settings are reset to the device's configured values.

If your institution's protocol requires periodic alarm verification and you wish to perform an alarm verification test (in a non-clinical environment), outside of Operational Check testing, you can connect the HeartStart XL+ to a simulator, then manually change the alarm limits to a setting which should cause the device to alarm. Look at the display and listen for the alarm. Be sure to reset the alarm limits to the appropriate settings before returning the device to a clinical environment.

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Figure 74 **Sample Operational Check Report**

Operational Check Report	Current Test Results:				
	General System Test:	Pass	Pads/Paddles ECG Test:	Pass	
HeartStart XL+	Therapy Knob:	Pass	Battery Test:	Pass	
S/N: (Device Serial Number)	Charge Button:	Pass	SpO2 Test:	Pass	
SW Rev: (Software revision)	Shock Button:	Pass	NBP Test:	Pass	
Current Operational Check:	Audio Test:	Pass	Printer Test:	Pass	
(Date, Time, Result)	Sync Button:	Pass			
	Therapy Delivery Test:	Pass			
Last Operational Check:	Leads ECG Test:	Pass			
(Date, Time, Result)					

Qty/Check List	Comments:
_ Defibrillator Inspection	
_ ECG Cable/Connectors	
_ Paddles/Pads	
_ Monitoring Electrodes	
_ Charged Battery	
_ AC Power Cord	
_ Printer Paper	
_ SpO2 Sensor	
_ NBP Cuff(s) & tubing	Inspected by _____
_ USB Connector	

NOTE: Information appearing in parenthesis in Figure 74 is replaced by the current setting when an actual Operational Check Report is printed. For example: (Device Serial Number) is replaced with the device's actual serial number when the report is printed.

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Operational Check Summaries

Selecting **Op Check Summary** from the Operational Check menu (see Figure 71) displays a summary of Operational Checks currently stored in the HeartStart XL+ (see Figure 75). Using the Navigation buttons, select the Operational Check report you want. Press the Menu Select button (see Figure 76) to print out or export the summary.

Figure 75 **Operational Check Summary**

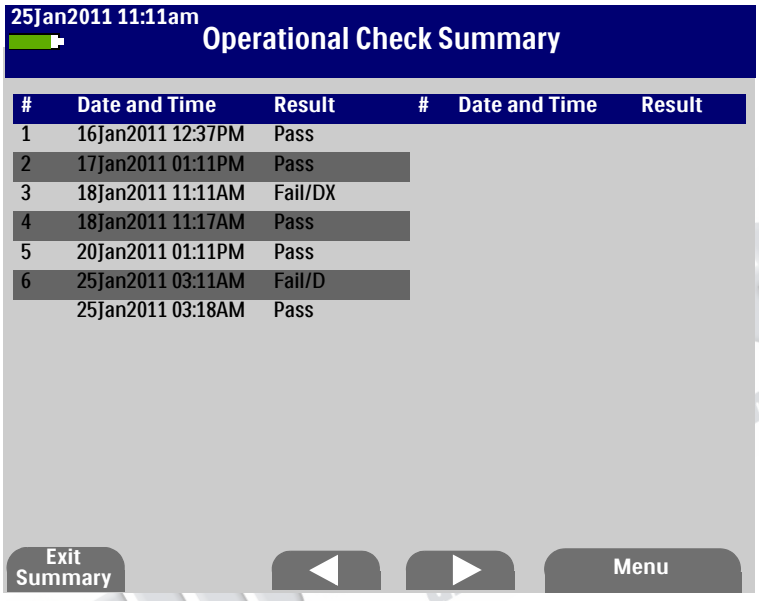
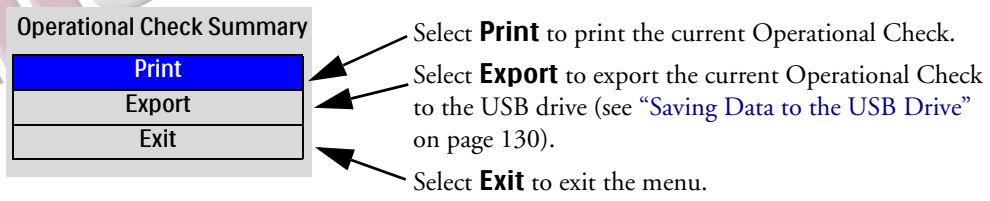


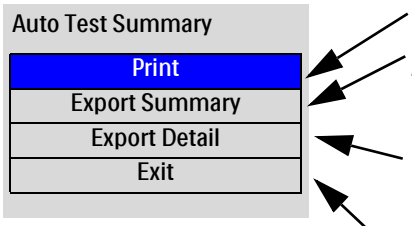
Figure 76 **Operational Check Summary Menu**


Operational Check Summary
Print
Export
Exit
Select Print to print the current Operational Check.
Select Export to export the current Operational Check to the USB drive (see "Saving Data to the USB Drive" on page 130).
Select Exit to exit the menu.

Auto Test Summaries

Selecting **Auto Test Summary** from the Operational Check menu (see Figure 71) displays a summary of automated test results currently stored in the HeartStart XL+. Using the Navigation buttons, select the summary you want and press the Menu Select button to print out or export the summary.

Figure 77 **Auto Test Summary Menu**



Select **Print** to print the Auto Test Summary.

Select **Export Summary** to export the selected Auto Test Summary to the USB drive. (See "Saving Data to the USB Drive" on page 130.)

Select **Export Detail** to export all Auto Test details to the USB drive (see "Saving Data to the USB Drive" on page 130).

Select **Exit** to exit the menu.

For more information, see "Automated Tests" on page 164.

NOTE: If you try to print a summary or report while the printer is printing another report or summary, the HeartStart XL+ asks you if you want to stop the current printing and begin the second one. Using the Navigation buttons, select your answer and press the Menu Select button.

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NOTES

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15

Maintenance

This chapter describes how to care for your HeartStart XL+ and its accessories.

Overview

Proper maintenance of the HeartStart XL+ is a simple, yet important factor in dependability. Attending to routine maintenance is vital to keeping the HeartStart XL+ ready to respond in an emergency.

Routine maintenance involves:

- Providing power so automated tests can run (see "Automated Tests" on page 164).
- Observing the Ready For Use (RFU) indicator to confirm the device's readiness (see "Ready For Use Indicator" on page 24).
- Performing Operational Checks and Shift Checks (see Chapter 14 "Operational and Shift Checks" on page 147).
- Caring for batteries (see "Battery Maintenance" on page 166).
- Cleaning the device and accessories (see "Cleaning Instructions" on page 170).
- Checking expiration dates on supplies and accessories, and ordering replacements (see Chapter 17 "Supplies & Accessories" on page 189).
- Timely calibration for those modules which require calibration. (See "Calibrating Batteries" on page 167 and the *HeartStart XL+ Service Manual* for NBP Calibration.)

WARNINGS: HeartStart XL+ service should only be performed by qualified service personnel, in accordance with the *HeartStart XL+ Service Manual*.

Electric shock hazards exist internally. Do not open device.

NOTE: Refer to the *HeartStart XL+ Service Manual* for information on the expected life of the device and components.

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Automated Tests

The HeartStart XL+ performs many maintenance activities including three tests that run automatically at regularly scheduled intervals when power is supplied and the device is off. The tests assess operational performance and alert you if a problem exists.

Results of tests associated with critical device functionality are reported through the RFU indicator and the Automated Test Summary Report. Results are also reported through statements on the HeartStart XL+'s display when the device is turned on. Table 40 provides a brief explanation of the tests and lists each test's frequency.

Table 40 **Automated Tests**

Test	Frequency	Description
Hourly	Every hour	Tests power supply, charge level of the battery, internal communication across all critical modules and components and also the device's internal temperature.
Daily	Daily after midnight according to the device's internal clock	Tests all hourly components as well as defibrillation, ECG, pacing, SpO_2, NBP and the printer.
Weekly	Weekly, after midnight Sunday morning according to the device's internal clock	Tests all daily components as well as various electrical circuit tests and administers a 150J shock internally to test the defibrillation circuitry.

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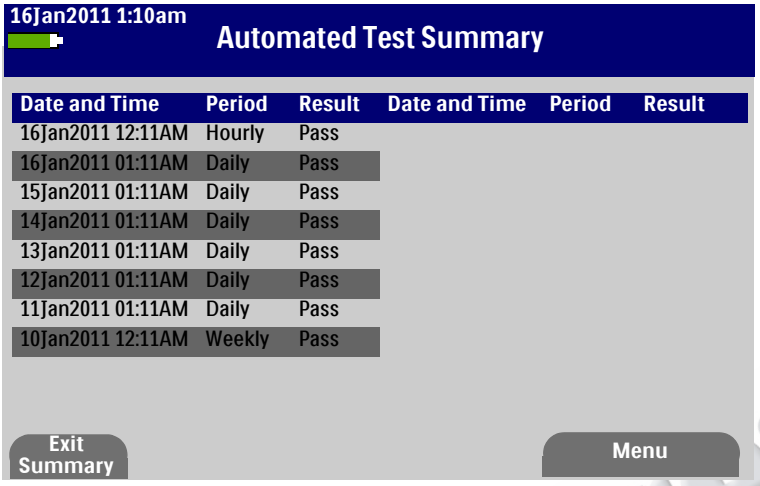
Auto Test Summaries

You can review, print and export all Auto Test Summaries the HeartStart XL+ performs.

To view a summary of Automated Tests:

1. Turn the Therapy knob to **Monitor**.
2. Press the Menu Select button.
3. Using the Navigation buttons, select **Other** and press the Menu Select button.
4. Select **Operational Check** and press the Menu Select button.
5. Select **Auto Test Summary** and press the Menu Select button. The message **Leaving clinical mode. Patient monitoring will be turned off.** appears.
6. Select **Yes** if you wish to continue. Select **No** to return to Monitor Mode. Press the Menu Select button to confirm your choice.
7. If you selected **Yes**, the HeartStart XL+ displays the Automated Test Summary screen (see Figure 78).

Figure 78 **Automated Test Summary**



Auto Test Summary Results

The Automated Test Summary reports results for the hourly, daily and weekly tests that have been performed. (See Table 41.) The AutoTest Summary lists the result of the most recent hourly test, the six most recent daily tests and the last 53 weekly tests. The table below describes each result and the corresponding RFU Indicator display. For more on the RFU Indicator see "Ready For Use Indicator" on page 24.

Table 41 **Auto Test Summary Results**

Result	RFU Indicator	Definition	Required Action
Pass	Hourglass	All tests passed.	None.
Fail/DX	Solid red X, chirp	Service required. A critical device failure has been detected.	Turn the Therapy knob to **Monitor**. A message indicating the problem is displayed. Refer to Chapter 16 "Troubleshooting" on page 173 for further action.
Fail/BW	Blinking red X	Service is not required but the battery is low or malfunctioning.	Charge the battery as soon as possible or replace it with a charged battery. You can charge the battery in the HeartStart XL+ by connecting the device to AC power.
Fail/CX	Solid red X, chirp	An ECG cable failure has been detected.	Replace the ECG cable and rerun Operational Check.
Fail/D	Hourglass	A non-critical failure has been detected.	Turn the Therapy knob to **Monitor**. A message indicating the problem is displayed. Refer to Chapter 16 "Troubleshooting" on page 173 for further action.

Printing/Exporting Auto Test Summaries

You can print or export the Auto Test Summaries from Operational Check. See "Operational Check" on page 151.

Battery Maintenance

Battery maintenance is essential to ensure that the battery's charge state is accurately reported, there is sufficient charge and capacity to operate your HeartStart XL+, and battery life is optimized. Remove faulty batteries from service immediately.

Battery maintenance begins when you first receive your device and continues throughout the life of the battery. Detailed information on battery care is available in the *Lithium Ion Battery Application Note* which was provided with your HeartStart XL+ and can also be found on the Philips website at www.philips.com/ProductDocs.

Table 42 lists battery maintenance activities and when they should be performed.

Table 42 **Battery Maintenance Activities**

Activity	When to perform
Visual inspection	As part of a standard Operational Check.
Charge the battery	Upon receipt; after use; if the **Low Battery** message is displayed.
Calibrate the battery	When the Operational Check results state **Calibration Required** or every 6 months, whichever comes first.
Store the battery	When not in use for an extended period of time, store the battery at a 20-40% charge.
Discard the battery	When there are visual signs of damage or you receive a message to replace the battery.

Battery Life

Battery life depends on the frequency and duration of use. When properly cared for and used in its intended environment, the HeartStart XL+ Lithium Ion battery has a useful life of approximately 3 years. Use outside those conditions could significantly reduce battery life. To optimize performance, a battery that is in the low battery condition (less than 40% remaining) should be charged as soon as possible.

Initializing Batteries

When opening a new battery for the first time, it needs to first be charged before the fuel gauge lights activate.

Charging Batteries

The HeartStart XL+ Lithium Ion battery needs to be charged in the HeartStart XL+. Insert the battery to be charged in the battery compartment and then plug the device into an AC power outlet.

Once AC power is supplied, the Battery Charging Indicator flashes green to indicate the battery is charging and the battery is ≤ 90 percent of capacity. The indicator turns solid green when the battery charge is > 90 percent of capacity and AC power is present. If no battery is installed or the installed battery is not functioning properly, the light remains off.

With the HeartStart XL+ turned off and the temperature between 0-35° C (32-95° F) , a fully discharged battery typically charges to 80% capacity in 2 hours and to 100% capacity in 3 hours. The battery charges at a slower rate with the device turned on.

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Charge Status

You can check the current charge status of a HeartStart XL+ Lithium Ion battery by:

- Pushing the fuel gauge button on the battery to illuminate the fuel gauge (see "Battery Fuel Gauge" on page 14). Each light represents approximately 20% of capacity.
- Turning the Therapy knob to any position and observing the battery power indicators displayed in the Status Area (see "Status Area" on page 27).

Calibrating Batteries

Battery capacity diminishes with use and age. Battery calibration ensures the fuel gauge provides accurate estimates of the charge remaining and it also checks to see if the battery is nearing the end of its useful life and should be discarded.

Calibrate your battery when the **Calibration Required** message is displayed or every 6 months, whichever comes first.

NOTE: Battery calibration can only be done while the battery is installed in the HeartStart XL+ and while in Service Mode. See the *HeartStart XL+ Service Manual* for more details. After successfully calibrating your battery, perform an Operational Check.

Storing Batteries

Batteries should be rotated regularly to ensure even usage. When storing batteries, make sure the battery terminals do not come in contact with metallic objects.

If storing batteries for an extended period of time, it is recommended they are stored between 15°C- 35° C (59-95° F). Storing batteries at a higher temperature significantly reduces the battery's life expectancy. Stored batteries should be charged every 2 months to 20-40% of their full capacity. They should be charged to full capacity before being put into use.

CAUTION: Do not store batteries in the HeartStart XL+ if the device is out of service for an extended period of time.

Discarding Batteries

Batteries should be discarded if there are visual signs of damage or if they fail calibration. They should be discarded in an environmentally safe manner.

WARNINGS: Properly dispose of or recycle batteries according to local regulations. Do not puncture, disassemble or incinerate batteries.

Be careful not to short the battery terminals because this could result in a fire hazard.

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General Battery Safety

The following general warnings and cautions apply to the HeartStart XL+ battery. Additional warnings and cautions specific to a particular battery feature are provided in the appropriate sections.

WARNINGS: Built-in safety circuits cannot protect against handling abuse. Adhere to all warnings and cautions in handling and using Lithium Ion batteries.

Keep batteries away from flame and other heat sources.

Do not short circuit the battery. Avoid placing batteries around metal objects that may short circuit the battery.

Avoid getting batteries wet or using batteries in high humidity environments.

Do not crush, dent or allow any deformation of the batteries.

Do not disassemble or open batteries. Do not attempt to alter or bypass the safety circuit.

Do not connect the battery to any other batteries.

CAUTIONS: Use caution when handling, using and testing batteries. Do not short circuit, crush, drop, mutilate, puncture, apply reverse polarity, expose to high temperatures or disassemble. Misuse or abuse could cause physical injury.

Avoid extreme shock and vibration to the battery.

Do not expose batteries to temperatures greater than 60 °C (140 °F). Excess temperatures may result in battery damage.

Wash skin with large amounts of water in the event of electrolyte leakage to prevent skin irritation and inflammation.

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Power-Related Alarms

Power-related alarms are generated for the conditions shown in Table Figure 43. Once generated, they appear as alarm messages on the HeartStart XL+ display. There are both audio and visual alerts. For more information on alarms, see "Alarms" on page 33.

Table 43 **Power-Related Alarms**

Alarm Message	Condition	Type of Alarm	Indication and Location
Low Battery	Battery power is low.	High Priority if pacing otherwise, low priority non-latching alarm	Red alarm message if pacing, cyan if not with audio tone in Battery Status area.
Shutting down in 1 min	Battery power is critically low. The device will shut down in 1 minute.	High Priority if pacing otherwise, medium priority non-latching alarm	Red alarm message if pacing, yellow if not with audio tone in Technical Alarm area.
Shutting Down Now	Battery power is critically low. The device is shutting down now.	High Priority Non-Latching	Red alarm message with audio tone in Technical Alarm area.
Equipment Disabled: System Failure	A low voltage has been detected.		
Battery Calibration Required	The battery needs to be calibrated.	Low Priority Non-Latching	Cyan alarm message with audio tone in Battery Status area
Battery Communication Failure	Communications between the device and the battery have failed.		
Replace Battery	The battery has reached its end of life.		Cyan alarm message with audio tone in Technical Alarm area

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Cleaning Instructions

Listed below are the recommended cleaning instructions for the HeartStart XL+ and its associated accessories.

CAUTIONS: The HeartStart XL+, along with its accessories and supplies, may not be autoclaved, steam sterilized, ultrasonically cleaned or immersed unless otherwise indicated in the *Instructions for Use* that accompany the accessory or supply.

Do not use abrasive cleaners or strong solvents such as acetone or acetone-based compounds.

Do not clean electrical contacts or connectors with bleach.

A soft cloth is recommended for cleaning the display window to prevent scratching.

Quaternary ammonium compounds such as Steris Coverage Plus NPD are not recommended for routine cleaning.

Disinfect the HeartStart XL+ as determined by your institution's policy to avoid damage to the device.

Defibrillator/Monitor, Paddles, Cables and Battery

You can clean the exterior of the HeartStart XL+, external paddles, therapy cables, ECG cables and battery by hand wiping with a clean cloth. Remove all soil (tissue, fluid, etc.) and wipe thoroughly with a water-dampened cloth before applying one of the following cleaning products:

- Isopropyl alcohol (70% solution in water)
- Mild soap and water
- Chlorine bleach (containing 6% sodium hypochlorite), 3% solution in water
- Cleaning solutions/wipes with milder Isopropyl alcohol and chlorine bleach concentrations

CAUTIONS: When cleaning, do not immerse. Wring any excess moisture from the cloth before cleaning and be sure to avoid pouring fluids on the device. Do not allow fluids to penetrate the exterior surfaces of the device.

No parts of the device (except sterilizable internal and external paddles) may not be ultrasonically cleaned, immersed, autoclaved or ETO sterilized.

The ECG cables may not be ultrasonically cleaned, immersed, autoclaved or steam sterilized.

NOTE: For information about cleaning and sterilizing internal and external sterilizable paddles, see the *Sterilizable Defibrillator Paddles Instructions For Use*.

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Printer Printhead

If the printout has light or varying print density, clean the printhead to remove any buildup of paper residue.

To clean the printhead:

1. Push the printer door latch to open the door.
2. Remove the roll of paper.
3. Clean the printhead surface (top, front of the compartment) with a cotton swap dipped in isopropyl alcohol.
4. Replace roll of paper and close door.

Side Pouches

After removing from the device, the side pouches may be cleaned by hand with mild soap and water and air dried. Do not wash or dry by machine.

SpO_2 Sensor and Cable

Follow the manufacturer's instructions to clean the SpO_2 sensor and cable.

NBP Cuff

Follow the manufacturer's instructions to clean the cuff.

HeartStart XL+ Disposal

Prior to disposal, remove the battery. Then dispose the device and accessories in accordance with your country's regulations for equipment containing electronic parts.

WARNINGS: Disposing the device with the battery inserted presents an potential shock hazard.

To avoid contaminating or infecting personnel, the environment or other equipment, make sure you disinfect and decontaminate the device and any appropriate accessories prior to disposal.

NOTE: This product consists of devices that may contain mercury, which must be recycled or disposed of in accordance with local, state or federal laws. Within this system, lamps in the display contain mercury.

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NOTES

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Troubleshooting

Overview

If the HeartStart XL+ detects an error or potential problem during use, it displays a textual message to guide you. These messages are often accompanied by a voice prompt or audible beeping tone. This chapter describes these statements that you see, along with other symptoms, and provides suggestions for what to do and resources for you to contact for further information.

Resolving Issues

If you are unable to resolve a problem using the suggestions in this chapter, run an Operational Check to determine if there is a malfunction requiring service. If a malfunction is identified, call for service and:

- If the malfunction is related to ECG monitoring, defibrillation or pacing, take the HeartStart XL+ out of service.
- If the malfunction is related to SpO_2 or NBP, take the device out of service if the function is essential to patient care in your institution.

Responding to Test Results

Results of Automated Tests associated with critical functionality are reported through the Ready For Use Indicator and the Automated Test Summary report (see "Automated Tests" on page 164).

To respond to errors reported through Operational Check, see "Operational Check Tests and Results" on page 155).

For further technical and repair information, refer to the *HeartStart XL+ Service Manual*.

WARNING: Product servicing and repair should only be performed by qualified service personnel.

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Device Info Report

While troubleshooting, it is often beneficial to know what versions of software and hardware your HeartStart XL+ contains. The Device Info Report provides that information.

To print a Device Info Report:

1. Press the Menu Select button.
2. Using the Navigation buttons, select **Other** and press the Menu Select button.
3. Select **Print Device Info** and press the Menu Select button to print the report.

The Device Info Report contains information on:

- Serial Number
- Software Revision
- Main Processor PCA
- Processor Module
- Installed Options
- Therapy Board
- Printer

If there is a device failure and the HeartStart XL+ cannot determine a version number, a **-?-** is displayed in its place.

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Symptoms

The following tables list symptoms, statements and messages that you may encounter while using the HeartStart XL+. The tables also provide possible causes and potential solutions. Symptoms are categorized by functionality.

NOTE: When troubleshooting issues related to connecting the patient to the HeartStart XL+, it is recommended that one single person follow the connection path from the patient to the device to assure a proper end-to-end connection.

Table 44 **General Problems**

Symptom	Possible Cause	Possible Solution
The HeartStart XL+ does not turn on.	There is no power.	Check the battery pack. Insert a fully charged battery. Connect the device to AC power.
Short battery life (battery appears to lose its charge quickly).	Battery may be nearing its end of life.	Calibrate the battery. Replace the battery.
Battery charge indicators seem inaccurate.	The battery may need calibration.	Calibrate the battery.
When turning the device on, it starts up in Service Mode and displays a **Therapy Not Available Due to Disabled Equipment** message. If you turned the device to AED or Manual Defibrillation Mode, **Begin CPR** is added to the message.	Clinical Mode is not available because of a device failure.	Begin CPR if needed. Run an Operational Check. If it fails or the problem continues, take the device out of use and call for service.
Audio is too low or absent.	The **QRS**, **Voice** or **Alarm** volume is configured to a **Very Soft** or **Off** setting.	Use the **Volume** menu to adjust the volume of the prompt.
	There is a problem with the device's speaker.	Run an Operational Check to confirm the speaker is operating.
All Setting Reset to Default Values message on display.	A power failure or critical software failure has occurred.	Reset alarms, waveforms, volumes and other settings previously defined for the current patient.
Critical Device Failure Detected. Service Required message on display.	A critical device failure has been detected at startup or during RFU testing. Clinical modes are disabled.	Run an Operational Check. If it fails or the problem occurs repeatedly, take the device out of use and call for service.
Equipment Disabled: System Failure message on display.		
Equipment Disabled: Therapy message on display.	A device failure has been detected at startup or during RFU testing. The device is unable to deliver therapy.	

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Table 44 **General Problems *(Continued)***

Symptom	Possible Cause	Possible Solution
Non-critical Device Failure Detected. Service Required message on display.	A non-critical device failure has been detected at startup or during RFU testing.	Review error and alarm messages on screen. Call for service.
Pads/Paddles Type Unknown message on display.	There is a problem with the Therapy cable and/or the device's Therapy port.	When prompted, pick the correct cable type from the menu and press the Menu Select button. (If you select the wrong cable type in error, unplug and re-plug in the cable.) Replace the Therapy cable. If problems persist, take the device out of use and call for service.
Replace Battery message on display.	The battery has reached its end of life.	Replace the battery.
Low Battery message on display.	The battery may not have enough remaining charge to provide six 200J shocks and 10 minutes of monitoring.	Connect to AC power. Insert a fully-charged battery.
Shutting Down in 1 min message on display.	Very low battery and the device is not connected to AC power.	
Shutting Down Now message on display.	Battery charge is depleted and the device is not connected to AC power.	Connect to AC power to restart the device.
Battery Calibration Required message on display.	The battery needs to be calibrated.	Connect to AC power. Insert a fully-charged battery. Calibrate battery before returning to service.
Battery Communication Failure technical alarm.	The HeartStart XL+ is not able to communicate with the battery.	Connect to AC power. Insert a fully-charged battery. If problems persist, call for service. If battery power is essential to patient care, take the device out of use.
The power gauge on the side of the battery does not work when you first receive the battery.	Battery was shutdown to prolong its life during shipping.	Insert the battery in a HeartStart XL+ for about 1 minute to awaken it.
One or more controls do not respond as expected (e.g. Lead Select button does not function, soft keys do not work).	There is a faulty control or connection problem.	Remove the device from use and call for service.
Arching or sparking during paddles-in-pocket test therapy discharge (Weekly Shock Test).	Debris or residue, such as electrolytic gel, on the surfaces of the paddles and/or paddles tray.	Clean paddles and paddles tray.

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Table 44 **General Problems *(Continued)***

Symptom	Possible Cause	Possible Solution
Trending data is not appearing on the display.	You might not be in Monitor Mode.	Make sure your device is in Monitor Mode before attempting to display trending information.
You receive a **Event Record Limit Reached** technical alarm.	You have reached the eight hour duration limit for the current event.	To continue event recording, you need to start a new event by powering the device off for 10 seconds and then turning it back on. Do not perform this function if patient safety is an issue.
You receive a **Event Storage Error** technical alarm.	A non-critical device failure has occurred.	Recording of events and waves has stopped. Restart device when it is appropriate to do so. If the alarm continues, call for service.
You receive a **USB Error** technical alarm.		Restart device when it is appropriate to do so. If the alarm continues, call for service.
You receive a **Device Temp High** technical alarm.	The device's internal temperature is above 65°C (149°F)	Turn the device off and allow to cool. If the problem persists, remove the device from use and call for service.
You receive a **Device Restarted Due to Error** technical alarm.	The previous shutdown was caused by an internal device error.	Run an Operational Check to diagnose the problem. If the problem persists, remove the device from use and call for service.
You receive a **Power Equipment Malfunction** technical alarm.	A power supply failure has occurred but no critical functions are affected.	
You receive an **Autotest Failure** technical alarm.	One of the Ready For Use tests failed to run to completion at its scheduled interval.	Take the device out of use and call for service.
	The device has been without power for more than one week.	Run an Operational Check to diagnose the problem. If the problem persists, remove the device from use and call for service.
You receive a **Power Test Failure** technical alarm.	The installed battery is unable to charge the device for defibrillation.	Insert a fully charged battery. Run an Operational Check to diagnose the problem. If the problem persists, remove the device from use and call for service.
You receive a **Non-Critical Device Error** technical alarm.	A non-critical software error has occurred.	Restart device when it is appropriate to do so. If the alarm continues, call for service.
Your device's display remains in Monitor Mode even when you switch to a different mode. Therapy is disabled.	The Therapy knob has failed an Operational Check.	Run a proper Operational Check to diagnose the problem. If the problem persists, remove the device from use and call for service.

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Table 45 **ECG Monitoring Problems**

Symptom	Possible Cause	Possible Solution
QRS beeper inaudible or beeps do not occur with each QRS complex.	The QRS volume is configured to **Off** or the setting is too low.	Configure the QRS beeper volume.
	The QRS volume was turned off or set too low through the Volume menu.	Adjust the volume through the Volume menu.
	The amplitude of the QRS complex is too small to detect.	Select a different lead.
Poor ECG signal quality (noisy trace, wandering baselines, etc.) from signal acquired through monitoring electrodes.	The monitoring electrodes are not making proper contact with the patient.	Check that the monitoring electrodes are properly applied. If necessary, prepare the patient's skin and apply new electrodes.
	The monitoring electrodes are out of date or dried out.	Check the date code on the electrodes. Do not open the electrode package until immediately prior to use.
	Radio frequency interference (RFI) is causing artifact.	Relocate or turn off equipment that may be causing RFI. Try repositioning the cables/leads.
	The ECG cable may be faulty.	Run an Operational Check with the ECG cable and check Leads ECG results. If the test fails, replace the ECG leadset and trunk cable.
Poor ECG signal quality (noisy trace, wandering baselines, etc.) from signal acquired through pads.	The pads are not making proper contact with the patient.	Ensure proper skin preparation and correct application. If necessary, apply new pads. Paddles are only for a quick look, not long term monitoring.
	The pads are outdated or dried out.	Check the date code on the pads. Do not open the pads package until immediately prior to use.
	Radio Frequency Interference (RFI) is causing artifact.	Relocate or turn off equipment that may be causing RFI. Try repositioning the Therapy cable.
	The Therapy cable may be faulty.	Run an Operational Check with the Therapy cable and check pads ECG results. If the test fails, replace the Therapy cable.
When monitoring with pads, there is a dashed line on the display instead of an ECG.	ECG data is not being acquired.	Confirm that the desired lead is selected. Check the pads, paddles or ECG cable connection. Check that the pads, paddles, or monitoring electrodes are properly applied.

NOTE: Viewing a patient's ECG through paddles is not recommended for long-term monitoring. See "Quick Look" on page 77.

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Table 45 **ECG Monitoring Problems *(Continued)***

Symptom	Possible Cause	Possible Solution
The Lead Select button does not respond as expected.	Device is in AED Mode.	The Lead Select button is disabled in AED Mode. To select a lead, exit AED Mode and enter Monitor or Manual Defibrillation Mode.
	Pads/paddles cannot be used for the primary ECG in Demand Mode pacing.	Exit pacing or choose Fixed Mode pacing.
	If a 3-Lead cable is in use or some wires in a 5-Lead cable are disconnected, augmented and V-leads may not be selectable.	Confirm all leads are connected.
Solid flat line - no waveform, no leads, **Cannot Analyze ECG** alarm	Short in the patient cable or leads.	Run an Operational Check with the ECG cable. If the test fails, run it without the ECG cable. If the test passes, replace the cable. If not, remove the device from use and call for service.
Pads/Paddles Off technical alarm	The multifunction electrode pads or paddles may be disconnected or not attached securely.	Check that the pads/paddles are properly applied. If necessary, replace the pads. Change the ECG in Wave Sector 1 to a lead derived from monitoring electrodes.
Cannot Analyze ECG technical alarm.	ECG data cannot be analyzed. An electrode may be disconnected or the analyzing algorithm cannot analyze the ECG signal.	Check ECG signal quality. If necessary, improve lead position or reduce patient movement.
ECG Equipment Malfunction technical alarm.	A device hardware failure was detected.	Disconnect the ECG cable and perform an Operational Check. If the Leads ECG test fails, remove the device from use and call for service. If the Leads ECG test passes, replace the ECG cable and perform another Operational Check.
Pads ECG Equipment Malfunction technical alarm.	A device hardware failure was detected.	Perform an Operational Check. If the Pads/Paddles ECG test fails with Therapy cable, disconnect the Therapy Cable from the device when prompted in order for the the Pads/Paddles ECG Test to run without the cable connected. If the Pads/Paddles ECG Test passes without the cable connected, replace the Therapy cable. If the test fails, remove the device from use and call for service.
Equipment Disabled: Therapy technical alarm.	A device failure has been detected. The device is unable to deliver therapy.	Run an Operational Check. If it fails or the problem occurs repeatedly, take the device out of use and call for service.

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Table 45 **ECG Monitoring Problems *(Continued)***

Symptom	Possible Cause	Possible Solution
Press "I,II.." Button to Select Another ECG Lead message on display.	The waveform in Wave Sector 1 is no longer valid and another ECG source is available.	Check that the monitoring electrodes/pads are properly applied. Use the Lead Select button to select another lead to monitor.
***Lead Wire* Off** message on the display.	The specified monitoring electrode is off or not making proper contact with the patient.	Check that the monitoring electrodes are properly applied. If necessary, prepare the patient's skin and apply new electrodes.
Check Limb Leads message on the display.	Two or more limb lead electrodes are off or not making proper contact with the patient.	Check that the limb lead electrodes are properly applied.

Table 46 **Defibrillation and Pacing Problems**

Symptom	Possible Cause	Possible Solution
Cannot Analyze ECG technical alarm.	ECG data cannot be analyzed. An electrode may be disconnected or the analyzing algorithm cannot analyze the ECG signal.	Check ECG signal quality. If necessary, improve lead position or reduce patient movement.
Equipment Disabled: Therapy technical alarm.	A device failure has been detected at startup or during RFU testing. The device is unable to deliver therapy.	Take the device out of use and call for service.
Connect Therapy Cable message is displayed.	Pads/Paddles are not connected when attempting to charge the device.	Connect the pads/paddles to the device.
	The Therapy cable is not connected to the device.	Connect the Therapy cable to the device.
Insert Connector, Apply Pads message is displayed.	Pads are not applied to the patient.	Properly apply pads to patient.
	Pads connector is not securely connected to the Therapy cable.	Check that pads connector and Therapy cable are securely connected.
Check ECG Lead message on display during Synchronized Cardioversion.	There is a leads off condition for the synchronizing lead.	Check the synchronizing lead and improve the connection.
Energy Limited to 50J message is displayed.	An attempt to deliver greater than 50J using internal paddles.	Select a lower energy. Only energies up to 50J are allowed using internal paddles.

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Table 46 **Defibrillation and Pacing Problems *(Continued)***

Symptom	Possible Cause	Possible Solution
Check Pads Connection From Patient to Device message on display.	A test load or defibrillator test plug is attached to the end of the Therapy Cable.	Remove the test load or defibrillator test plug and attach multifunction electrode pads.
	Pads impedance is less than 10 ohms.	Check pads connection with the patient.
Charge Cancelled message is displayed.	Therapy cable is not attached. Pads/paddles connection compromised.	Make sure the Therapy cable is connected and the pads/paddles are making proper contact with the patient.
	The Shock button was not pressed within the configured time period.	No action required. If desired, charge the device and press the Shock button.
Press Paddles Firmly message is displayed.	A shock has been aborted due to high impedance.	Check paddles connection with the patient. Remove paste, moisture, or any other conductive material between the pads and patient.
Press Pads Firmly message is displayed.		Check pads connection with the patient.
Replace Pads message is displayed.	A shock has been aborted due to high impedance - second notice.	Replace the pads and check connection with patient.
Reapply Pads to Dry Chest message on display.	A shock has been aborted due to low impedance.	Confirm proper skin prep and reapply pads.
Paddles Must Not Be Touching Each Other message on display.		Confirm that paddles are not touching each other when placed on the patient's chest. Remove paste, moisture, or any other conductive material between the pads and patient.
Press Pads Firmly message on display.	A shock was delivered but there was marginal impedance.	Check pads connection with the patient.
Press Paddles Firmly for Next Shock message on display.		Check paddles connection with the patient.
Select Therapy Cable Type message on display.	The device can't detect the type of Therapy cable attached.	Select the proper Therapy cable from the list presented.
Therapy Not Available Due to Disabled Equipment message is displayed.	A device failure has occurred.	Run an Operational Check to diagnose the problem. If the device is in use at the time of the message, begin CPR if indicated.
Press "I,II.." Button to Select Another ECG Lead message on display.	The waveform in Wave Sector 1 is no longer valid and another ECG source is available.	Check that the monitoring electrodes/pads are properly applied. Use the Lead Select button to select another lead to monitor.
Pacing Stopped. Power Interrupted technical alarm.	Appears after power is restored to indicate there was a loss of power during pacing.	Pacing does not restart automatically. If indicated, resume pacing.

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Table 46 **Defibrillation and Pacing Problems *(Continued)***

Symptom	Possible Cause	Possible Solution
Pacing Stopped. Pads Off technical alarm.	Proper pads contact has been lost with the patient.	Check pads connection with patient. Confirm proper skin prep. Replace pads if necessary. Resume pacing.
Pacing Stopped. Device Error technical alarm.	The HeartStart XL+ has detected an error which prevents pacing therapy delivery.	Replace the defibrillator. Remove the device from use and call for service.
Pacing Stopped. Pads Cable Off technical alarm.	The Therapy cable is disconnected from the device.	Check all Therapy cable connections. Replace pads if necessary. Resume pacing.
Pacing Stopped. Leads Off technical alarm.	The primary ECG lead has become invalid.	Check that the monitoring electrodes are applied properly to the patient. Check cable connections. Resume pacing.
Shock Aborted prompt but you see a physiological response from the patient and the Shock Counter remains unchanged.	Poor skin contact, pads are not properly connected to the patient. Minimal patient movement is possible in this situation as the defibrillator may deliver a small amount of energy.	Make sure the pads are applied properly. Replace pads if necessary.

NOTE: Once the reason for the Pacing Stopped alarm has been resolved, that part of the alarm message is removed from the display. You must press the **[Start Pacing]** soft key to resume pacing and remove the remainder of the alarm from the display

Table 47 **SpO_2 Monitoring Problems**

Symptom	Possible Cause	Possible Solution
The SpO_2 waveform is not displayed.	The sensor is not properly connected or the sensor cable is damaged.	Check the sensor connection and cable. Try another sensor.
	The SpO_2 waveform is not configured to be displayed and there is not an unused wave sector.	Use the Displayed Waves menu to select a wave sector to display the SpO_2 waveform.
	You are in AED Mode and SpO_2 waveform is not configured to be displayed or SpO_2 is non-pulsatile.	Configure AED Mode to use SpO_2.

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Table 47 **SpO_2 Monitoring Problems *(Continued)***

Symptom	Possible Cause	Possible Solution
SpO_2 Non Pulsatile technical alarm.	The patient's pulse is absent or too weak to be detected or the sensor has come off.	Check perfusion at the measurement site. Check that the sensor is applied properly. Make sure the sensor site has a pulse. Relocate the sensor to another site with improved circulation. If the message occurs during an NBP measurement on the same limb, wait until the NBP measurement is finished. Try another sensor.
SpO_2 Erratic technical alarm. The SpO_2 numeric value is replaced with a -?-.	SpO_2 measurements are erratic.	Check that the sensor is applied properly. Make sure the sensor site has a pulse. Relocate the sensor to another site with improved circulation. Try another sensor.
SpO_2 Noisy Signal technical alarm.	Excessive patient movement or electrical interference.	Minimize patient movement. Make sure the sensor cable is not positioned too close to power cables.
SpO_2 Interference technical alarm.	Ambient light is too high.	Cover the sensor with an opaque material to minimize ambient light. Make sure the sensor cable is not positioned too close to power cables. Make sure that the sensor cable is not damaged.
SpO_2 Unplugged technical alarm.	The sensor is not connected. There is too much interference. The sensor is damaged.	Check the SpO_2 connection. Try another sensor.
SpO_2 Sensor Malfunction technical alarm.	The SpO_2 sensor or cable is faulty.	Try another sensor. If the problem persists, call for service of the SpO_2 module. If SpO_2 monitoring is essential to patient care, take the device out of use.
SpO_2 Equipment Malfunction technical alarm.	Faulty SpO_2 hardware.	Call for service of the SpO_2 module. If SpO_2 monitoring is essential to patient care, take the device out of use.

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Table 47 **SpO_2 Monitoring Problems *(Continued)***

Symptom	Possible Cause	Possible Solution
SpO_2 Extended Update technical alarm. The SpO_2 numeric value is replaced with a -?-.	An NBP measurement or an excessively noisy signal is delaying display/update of the SpO_2 measurement for more than 30 seconds.	Wait until the NBP measurement is complete. Try another sensor site. Move sensor to a different limb than the NBP cuff.
SpO_2 Low Perfusion technical alarm. The SpO_2 numeric value is replaced with a -?-.	The SpO_2 signal is too low to give an accurate reading.	Check that the sensor is applied properly. Make sure the sensor site has a pulse. Relocate the sensor to another site with improved circulation. Try another sensor.
SpO_2 Error technical alarm.	A non-critical device failure has occurred.	Restart device when it is appropriate to do so. If the alarm continues, call for service of the SpO_2 module. If SpO_2 monitoring is essential to patient care, take the device out of use.

Table 48 **NBP Monitoring Problems**

Symptom	Possible Cause	Possible Solution
Measurement cycle doesn't automatically start.	NBP is not configured for automatic measurements.	Check/modify the configuration as needed.
	Automatic measurements are not scheduled for the current patient.	Use the Measurements/Alarms menu to define an automatic schedule of measurements for the current patient.
	The **[Start NBP]** soft key has not been pressed.	Press the **[Start NBP]** soft key.
The pump operates but the cuff does not inflate or fails to inflate fully.	Defective cuff.	Replace the cuff.
	Poor connection between the cuff and the HeartStart XL+.	Check connections and replace tubing if needed.
NBP measurements appear high/low.	The cuff size is too small/large for the patient.	Use the correct cuff size and take another measurement.
NBP Cuff Not Deflated technical alarm. The NBP numeric value is replaced with a -?-.	The cuff has not fully deflated after 3 minutes.	Remove the cuff from the patient. Release pressure in the cuff (disconnect cuff from tubing). Replace the cuff. If the problem persists, call for service.
NBP Cuff Overpressure technical alarm. The NBP numeric value is replaced with a -?-.	The NBP cuff pressure has exceeded the overpressure safety limit of 300 mmHg/40 kPa.	The cuff should deflate automatically. If not, remove cuff from patient and deflate. Turn device off to reset the alarm and restart NBP.

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Table 48 **NBP Monitoring Problems *(Continued)***

Symptom	Possible Cause	Possible Solution
NBP Measurement Failed technical alarm. The NBP numeric value is replaced with a -?-.	A measurement value could not be obtained.	Check cuff size and placement.
NBP Calibration Overdue technical alarm.	The NBP module needs calibration. Calibration should be performed once a year.	Call for service and perform NBP calibration within two weeks. After two weeks, do not use the NBP monitoring capabilities until calibration has been performed. If NBP monitoring is essential to patient care, take the device out of use.
NBP Equipment Malfunction technical alarm.	Faulty NBP hardware.	
NBP Error technical alarm.	A non-critical device failure has occurred.	

Table 49 **Printing Problems**

Symptom	Possible Cause	Possible Solution
Paper won't move.	Paper improperly loaded, jammed, or wet.	Reload paper or clear jam. If paper is wet, replace with a fresh, dry roll.
Paper moves and then stops.	Door improperly latched.	Check door latch.
	Paper improperly loaded or jammed.	Reload paper or clear jam.
Paper moves but printing is faint or absent.	Paper roll improperly installed.	Check that the paper is installed correctly.
	Incorrect paper type.	Use only recommended paper type.
	Printhead temperature approaching maximum recommended operating temperature.	Wait until the printer cools down to restart printing. If there is a lot of black printed on the paper, check ECG for excessive noise.
Paper moves but print quality is poor or some dots are missing.	Dirty printhead.	Clean the printhead.
White line running along paper.		
Loud buzzing or grinding noise.	Print door improperly latched.	Check door latch.
Printer Out Of Paper technical alarm.	The printer has run out of paper.	Reload with new fresh, dry roll of paper.
Printer Door Open technical alarm.	The printer door is not fully closed.	Open the printer door and reclose such that it snaps into place.

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Table 49 **Printing Problems *(Continued)***

Symptom	Possible Cause	Possible Solution
Printer Font Unavailable technical alarm.	The required font is unavailable for the currently installed language.	If printing is essential to patient care, take the device out of use and call for service.
Printer Malfunction technical alarm.	The printer is faulty or there is a problem communicating with the printer.	Turn the HeartStart XL+ off for 15 seconds and then turn it back on. If the problem persists, call for service. If printing is essential to patient care, take the device out of use.
Printer Error technical alarm.	A non-critical device failure has occurred.	Restart device. If the error continues and printing is essential to patient care, take the device out of use and call for service.

Table 50 **USB Drive Problems**

Symptom	Possible Cause	Possible Solution
Insert Compatible USB Device message on display.	A non-compatible USB device has been inserted in the USB port.	Use only a compatible USB device to store data from the HeartStart XL+. See "USB Device" on page 205.
You can't save data to the USB flash drive.	The USB flash drive is full.	Delete or remove files from the flash drive to free up space or use a different flash drive.
You can't import a configuration file from the USB flash drive.	The flash drive does not contain a configuration file.	Save a new configuration file to the flash drive and re-try.
USB Flash Drive Error message on display.	The USB flash drive was removed during data transfer.	Re-insert the USB flash drive and re-try.
Error Reading Configuration Data message on display.	The configuration file has become corrupted.	Save a new configuration file to the flash drive and re-try.
USB Power Overload technical alarm.	A USB power overload has been detected at the USB port.	Turn the device off for 15 seconds. Replace the USB device. If the problem also occurs with a second USB device, call for service.

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Calling For Service

For telephone assistance, call the Response Center nearest to you or visit Philips' website at www.healthcare.philips.com.

In the United States call: 1-800-722-9377.

For other telephone numbers worldwide:

1. Visit www.healthcare.philips.com.
2. Click on the appropriate region of the world where you are located.
3. Click on the "Healthcare" dropdown menu.
4. Click on the "Contact Us" side menu.

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Supplies & Accessories

This chapter provides information on the various supplies and accessories for the HeartStart XL+.

Ordering Replacement Supplies and Accessories

To order accessories and supplies:

- Visit our Healthcare web site at: http://www.medical.philips.com/main/products/resuscitation/products/supplies.
- In the US, call 800-225-0230 for pads, electrodes, cables, paper, etc.
- Outside the US, contact your local Philips Healthcare Sales Office or your authorized Philips Healthcare Dealer or Distributor.

WARNINGS: Use only multifunction electrode pads, battery and accessories listed in this *Instructions for Use*. Substitutions may cause the HeartStart XL+ to function improperly. For example, some electrodes may be subject to large offset potentials due to polarization.

Use single-use supplies and accessories only once.

Use multifunction electrode pads prior to their expiration date. Discard pads after use. Do not reuse pads. Do not use for more than 8 hours of continuous pacing.

Approved Supplies and Accessories

Table 51 **Supplies and Accessories**

Part Number	Description
Multifunction Electrode Pads	
M3501A	Adult/Child Pads, barrel connector, AAMI
M3504A	Infant Pads, barrel connector, AAMI
M3713A	HeartStart Adult/Child Plus Pads
M3716A	HeartStart Adult/Child Radiolucent Pads
M3717A	HeartStart Infant Plus Pads
M3718A	HeartStart Adult/Child Radiotransparent/Reduced Skin Irritation Pads
M3719A	HeartStart Infant Radiotransparent/Reduced Skin Irritation Pads
989803166021	HeartStart Adult/Child Preconnect Pads
989803158211	HeartStart Adult (1 set)
989803158221	HeartStart Adult (5 sets)
989803139261	SMART Pads II Adult/Child/Infant (for handoff only)

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Table 51 **Supplies and Accessories *(Continued)***

Part Number	Description
Hands-Free Pads Therapy Cables	
M3507A	Defibrillator Pads Hands-Free Cable, barrel style (2.2 m/7 ft.)
M3508A	Defibrillator Pads Hands-Free Cable, plug style (2.2 m/7 ft.)
05-10200	Pads Adapter (use with M3507A)
External Paddles	
M3543A	External Paddles
M4745A	Sterilizable External Paddles
M4759A	Paddle Electrode Replacement
Internal Switched Paddles	
M4741A	7.5cm Switched Internal Paddles
M4742A	6.0cm Switched Internal Paddles
M4743A	4.5cm Switched Internal Paddles
M4744A	2.8cm Switched Internal Paddles
Internal Switchless Paddles	
M1741A	7.5cm Switchless Internal Paddles
M1742A	6.0cm Switchless Internal Paddles
M1743A	4.5cm Switchless Internal Paddles
M1744A	2.8cm Switchless Internal Paddles
3-Lead ECG Cable Sets	
M1500A	3-lead ECG Trunk Cable (AAMI)
M1510A	3-lead ECG Trunk Cable (IEC)
M1605A	3-lead ECG Set with Snaps (AAMI)
M1615A	3-lead ECG Set with Snaps (IEC)
M1669A	3-lead ECG Trunk Cable (AAMI/IEC)
M1671A	3-lead ECG grabber (AAMI/ICU)
M1672A	3-lead ECG set ICU grabber (IEC)
M1673A	3-lead ECG set with snaps (ICU)
M1674A	3-lead ECG set with snaps (IEC, ICU)
M1675A	3-lead ECG set with grabbers (OR)
M1678A	3-lead ECG set, grabber (IEC, OR)
M3526A	3-wire lead set and plug, snap (AAMI)
M3528A	3-wire lead set and plug, snap (IEC)

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Table 51 **Supplies and Accessories *(Continued)***

Part Number	Description
5-Lead ECG Cable Sets	
M1520A	5-lead ECG Trunk Cable (AAMI)
M1530A	5-lead ECG Trunk Cable (IEC)
M1625A	5-lead ECG set with snaps (AAMI)
M1635A	5-lead ECG set with snaps (IEC)
M1644A	5-lead ICU snaps (AAMI)
M1645A	5-lead ICU snaps (IEC)
M1668A	5-lead ECG Trunk Cable (AAMI/IEC)
M1949A	5 plus 5 ECG Trunk Cable (AAMI/IEC)
M1968A	5-lead ICU grabber (AAMI)
M1971A	5-lead ICU grabber (IEC)
M1973A	5-lead OR grabber (AAMI)
M1974A	5-lead OR grabber (IEC)
6-Lead ECG Cable Sets	
M1667A	6-lead Trunk Cable (AAMI/IEC)
M1680A	6-lead ICU grabber, limb (AAMI)
M1681A	6-lead ICU grabber, limb (IEC)
M1682A	6-lead ICU snap, limb (AAMI)
M1683A	6-lead ICU snap, limb (IEC)
M1684A	6-lead OR grabber, limb (AAMI)
M1685A	6-lead OR grabber, limb (IEC)
10-Lead ECG Cable Sets	
M1663A	10-lead Trunk Cable (AAMI/IEC)
M1665A	10-lead Trunk Cable (AAMI/IEC)
M1682A	6-lead ICU snap, limb (AAMI)
M1683A	6-lead ICU snap, limb (IEC)
M3525A	10-lead ECG patient Trunk Cable, 12-pin
ECG Monitoring Electrodes	
M2202A	High-Tack Foam ECG Electrodes — 5 electrodes/pack (60 packs/case)
ECG Sync Out Cables	
M1783A	12-pin Sync Cable (8 feet)
M5526A	12-pin Sync Cable (25 feet)

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Table 51 **Supplies and Accessories *(Continued)***

Part Number	Description
NBP Interconnect Tubing	
M1598B	Adult Pressure Interconnect Cable (1.5m)
M1599B	Adult Pressure Interconnect Cable (3m)
Reusable Blood Pressure Cuffs	
40400A	Reusable Cuff Kit, 3 sizes (Pediatric, Adult, Large Adult)
40400B	Reusable Cuff Kit, 5 sizes (Infant, Pediatric, Adult, Large Adult, Thigh)
40401A	Traditional Reusable Cuff — Infant
40401B	Traditional Reusable Cuff — Pediatric
40401C	Traditional Reusable Cuff — Adult
40401D	Traditional Reusable Cuff — Large Adult
40401E	Traditional Reusable Cuff — Thigh
M4552B	Easy Care Reusable Cuff — Infant
M4553B	Easy Care Reusable Cuff — Pediatric
M4554B	Easy Care Reusable Cuff — Small Adult
M4555B	Easy Care Reusable Cuff — Adult
M4556B	Easy Care Reusable Cuff — Adult Long
M4557B	Easy Care Reusable Cuff — Large Adult
M4558B	Easy Care Reusable Cuff — Large Adult X-Long
M4559B	Easy Care Reusable Cuff — Thigh
M1571A	Multi-Patient Comfort Cuffs — Infant
M1572A	Multi-Patient Comfort Cuffs — Pediatric
M1573A	Multi-Patient Comfort Cuffs — Small Adult
M1574A	Multi-Patient Comfort Cuffs — Adult
M1575A	Multi-Patient Comfort Cuffs — Large Adult
M1576A	Multi-Patient Comfort Cuffs — Thigh

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Table 51 **Supplies and Accessories *(Continued)***

Part Number	Description
Disposable Blood Pressure Cuffs	
M1874A	Disposable Cuff — Infant
M1875A	Disposable Cuff — Pediatric
M1876A	Disposable Cuff — Small Adult
M1877A	Disposable Cuff — Adult
M1878A	Disposable Cuff — Large Adult
M1879A	Disposable Cuff — Thigh
M4572B	Soft Single-Patient Disposable Cuff — Infant
M4573B	Soft Single-Patient Disposable Cuff — Pediatric
M4574B	Soft Single-Patient Disposable Cuff — Small Adult
M4575B	Soft Single-Patient Disposable Cuff — Adult
M4576B	Soft Single-Patient Disposable Cuff — Adult X-Long
M4577B	Soft Single-Patient Disposable Cuff — Large Adult
M4578B	Soft Single-Patient Disposable Cuff — Large Adult X-Long
M4579B	Soft Single-Patient Disposable Cuff — Thigh
SpO_2 Sensors and Cables	
M1131A	Disposable SpO_2 Sensor — Adult/Pediatric Finger
M1132A	Disposable SpO_2 Sensor — Pediatric
M1133A	Disposable SpO_2 Sensor — Neonatal/Adult (for adults only - any finger except thumb)
M1191A	Reusable SpO_2 Sensor — Adult finger
M1191B	Reusable SpO_2 Sensor — Adult finger
M1191AL	Reusable SpO_2 Sensor — Adult finger (3m cable)
M1191BL	Reusable SpO_2 Sensor — Adult finger (3m cable)
M1191T	Reusable SpO_2 Sensor — Adult finger (9-pin connector)
M1192A	Reusable SpO_2 Sensor — Pediatric/Small Adult
M1192T	Reusable SpO_2 Sensor — Pediatric Finger (9-pin connector)
M1194A	Reusable SpO_2 Sensor — Adult/Pediatric ear clip
M1195A	Reusable SpO_2 Sensor — Infant
M1196A	Reusable SpO_2 Sensor — Adult clip
M1196S	Reusable SpO_2 Sensor — Adult clip (2m)
M1196T	Reusable SpO_2 Sensor — Adult clip (9-pin connector)
M1902B	Disposable SpO_2 Sensor — Infant digit (available outside the U.S. only)
M1903B	Disposable SpO_2 Sensor — Pediatric Finger (available outside the U.S. only)
M1904B	Disposable SpO_2 Sensor — Adult Finger (available outside the U.S. only)

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Table 51 **Supplies and Accessories *(Continued)***

Part Number	Description
M1941A	SpO_2 Extension Cable (2m)
M1943A	Reusable SpO_2 Sensor Adapter Cable (1m) — Use with M1903B/M1904B
M1943AL	Reusable SpO_2 Sensor Adapter Cable
Paper	
40457C	50 mm Chemical Thermal Paper, gray grid (10 rolls)
40457D	50 mm Chemical Thermal Paper, gray grid (80 rolls)
Adapters	
M4740A	Adapter for use with internal switchless paddles
05-10200	Adapter for M3507A. Changes barrel cable to flat (removable or permanent) for M37xxA pads
Power	
989803167281	HeartStart XL+ Lithium Ion Battery
Data Management	
989803171261	USB Data Drive
Accessory Pouches	
989803171281	One therapy and one monitoring accessory system
989803171291	Three cable wraps (one each for ECG, hands-free therapy cable, external paddles)
Mounting Solutions	
989803171701	Bed Rail/Roll Stand Hook
PH-0050-60	GCX Roll Stand with basket (orderable through GCX)
PH-0050-03	GCX Flush Wall Mount (orderable through GCX)
Test Loads and Test Plug	
M1781A	Test Load for use with M3507A Pad Cable
M3725A	Test Load for use with M3508A Pad Cable
989803171271	Defibrillator Test Plug for M3508A Cable

18

Specifications

This chapter includes:

- HeartStart XL+ specifications. See below.
- Symbol and abbreviation definitions, see "Symbol Definition" on page 206 and "Abbreviation Definitions" on page 208.
- Electromagnetic Compatibility, see "Electromagnetic Compatibility" on page 209.

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Specifications

General

Dimensions: 29.6 cm (W) x 23 cm (H) x 27.9 cm (D); 11.6 in (W) x 9 in (H) x 10.9 in (D)

Weight: 14.7 lbs/6.6 kg (includes one battery, one new roll of paper, one Therapy cable). Incremental weight of external standard paddles and paddle tray is less than 3 lbs (1.3 kg).

Standard Operator Position: Within one meter (3 feet) of the device.

Power: Rechargeable Lithium Ion battery; AC power using a protectively grounded outlet.

Alarm Tone and Voice Message Volume Range: Maximum - 85 dB(A), Minimum - 45 dB(A).

Alarm Tone Volumes:

Imminent Shutdown - Continuous tone alternating between 1000 and 2100 Hz.
High Priority - Tone of 960 Hz lasting 0.5 sec repeated every second.
Medium Priority - Tone of 480 Hz lasting 1 sec repeated every two seconds.
Low Priority - Tone of 960 Hz lasting 0.25 sec repeated every two seconds.

Visual Alarm Characteristics:

High Priority - Flashing at 2 Hz with 50% duty cycle (a .25-sec flash twice every second).
Medium Priority - Flashing at 0.5 Hz with 50% duty cycle (a 1-sec flash every other second).
Low Priority - Constant on.
See Figure 36 on page 35 for the relative size of the alarms on the display.

Defibrillator

Waveform: Biphasic Truncated Exponential. Waveform parameters adjusted as a function of patient impedance.

Shock Delivery: Via multifunction electrode pads or paddles.

Shock Series: Configurable energy escalation in a series.

Leads Off Sensing and PCI Sensing for Pads/Paddles: Apply 500nA rms (571Hz); 200uA rms (32KHz)

Table 52 **Delivered Energy Accuracy**

Nominal Delivered Energy vs. Load Impedance							
Selected Energy	Load Impedance (ohms) ±2%						
	25	50	75	100	125	150	175
1 J	1.2	1.3	1.3	1.2	1.1	1.0	0.9
2 J	1.7	2.0	2.1	2.0	1.9	1.7	1.6
3 J	2.6	3.0	3.1	3.2	3.2	3.1	2.9
4 J	3.5	4.0	4.2	4.3	4.4	4.5	4.3
5 J	4.3	5.0	5.2	5.4	5.5	5.6	5.4
6 J	5.2	6.0	6.3	6.5	6.6	6.7	6.5
7 J	6.1	7.0	7.3	7.6	7.8	7.8	7.6
8 J	6.9	8.0	8.4	8.6	8.9	8.9	8.7
9 J	7.8	9.0	9.4	9.7	10	10	9.8
10 J	8.7	10	10	11	11	11	11
15 J	13	15	16	16	17	17	16
20 J	17	20	21	22	22	22	22
30 J	26	30	31	32	33	33	33
50 J	43	50	52	54	55	56	54
70 J	61	70	73	76	78	78	76
100 J	87	100	105	108	111	111	108
120 J	104	120	126	130	133	134	130
150 J	130	150	157	162	166	167	163
170 J	147	170	178	184	188	189	184
200 J	173	200	209	216	222	223	217

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The delivered energy accuracy is ±10% or ±1J whichever is greater for all energy settings

Charge time:

3 seconds to the recommended adult energy level (150 Joules) with a new fully-charged battery installed.

Less than 5 seconds to the selected energy level (up to 200 Joules) with a new fully charged battery installed.

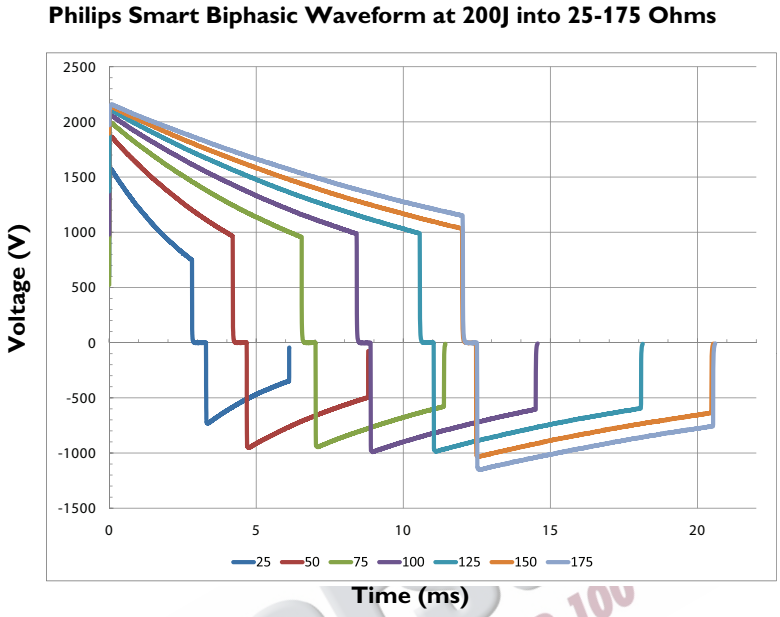
Less than 15 seconds to the selected energy level while connected to AC power only.

The device powers on in manual defibrillation mode ready to deliver shock in less than 8 seconds plus applicable charge time, assuming an immediate selection of an energy and initiation of a charge, even at 90V AC and after 15 maximum energy discharges.

The device powers on in AED mode ready to deliver shock in less than 17 seconds plus applicable charge time.

Patient Impedance Range: Minimum: 25 ohm (external defibrillation); 15 ohm (internal defibrillation); Maximum: 250 ohm. Actual functional range may exceed these values.

Figure 79 **Smart Biphasic Waveform**



Manual Defibrillation Mode

Manual Output Energy (Selected): 1-10, 15, 20, 30, 50, 70, 100, 120, 150, 170, 200 Joules; maximum energy limited to 50J with internal paddles.

Controls: On/Off Therapy knob, Charge, Shock, Sync, ECG Lead Select, Patient Selection, Print, Mark Events, Reports, Alarms, Menu Select, Navigation.

Energy Selection: Front panel Therapy knob.

Charge Control: Front panel button; button on external paddles.

Shock Control: Front panel button; buttons on external or switched internal paddles.

Synchronized Control: Front panel Sync button.

Synchronized Shock Timing: Maximum time from R-Wave detected to shock delivered is 25ms, as measured with oscilloscope from peak of input QRS wave to leading edge of defibrillation discharge into a 50 ohm test load.

Indicators: Text prompts, audio alerts, QRS beeper, battery status, Ready For Use (RFU), External Power, Sync Mode.

Armed Indicators: Charging/charged tones, flashing shock button on front of panel and on external paddles, energy level indicated on the display.

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AED Mode

AED Energy Profile: 150 Joules for Adult/50 J for Infant/Child (factory default) nominal into a 50 ohm test load.

AED Controls: On/Off, shock.

Text and Voice Prompts: Extensive text/audible messages guide user through a user-configured protocol.

Indicators: Monitor display messages and prompts, voice prompts, battery status, RFU, external power.

Armed Indicators: Charging/charged tones, flashing shock button, energy level indicated on the display.

ECG analysis: Evaluates patient ECG and signal quality to determine if a shock is appropriate and evaluates connection impedance for proper defibrillation pad contact.

Shockable Rhythms: SMART Analysis is designed to shock ventricular fibrillation, ventricular flutter and polymorphic ventricular tachycardia. It is designed to avoid delivering a shock for rhythms that are commonly accompanied by a pulse or rhythms that would not benefit from an electrical shock.

Shock Advisory Algorithm Sensitivity: Meets AAMI DF39 requirements and AHA recommendations; Adult: Ventricular Fibrillation - 90% with lower confidence limit (LCL) of 87 %, Polymorphic Ventricular Tachycardia and Ventricular Flutter - 75% with LCL of 67 %; Infant/Child: Ventricular Fibrillation - 90% with LCL of 87 %.

Shock Advisory Algorithm Specificity: Meets AAMI DF39 requirements and AHA recommendations; Normal Sinus Rhythm - 99% with LCL of 97%; Asystole - 95% with LCL of 92%; Other non-shockable Rhythms - 95% with LCL of 88%.

ECG and Arrhythmia Monitoring

Inputs: Up to 3 ECG waves may be viewed on the display and up to 2 waves printed simultaneously. Lead I, II or III is obtained through the 3-wire ECG cable and separate monitoring electrodes. With a 5-Lead ECG cable, leads aVR, aVL, aVF and V can also be obtained. Pads ECG is obtained through two multifunction electrode pads.

Lead Fault: Messages and dashed lines appear on the display if an electrode or lead becomes disconnected.

Pad Fault: Dashed line appears on the display if a pad becomes disconnected.

Heart Rate Display: Digital readout on the display from 16 to 300 bpm (Adult Patient Category) or 16 to 350 bpm (Infant/Child), with an accuracy of ±10% or ±5 bpm whichever is greater.

Heart Rate/Arrhythmia Alarms: HR high/low, Asystole, VFIB/V-TACH, VTACH, Extreme Tachy, Extreme Brady, PVC rate, Pacer Not Capture, Pacer Not Pacing.

Common Mode Rejection: 105 dB for Leads ECG, 96 dB for pads ECG.

ECG Size: 1/4x, 1/2x, 1x, 2x, 4x, auto gain (1x gain is 10mm/mV on the printed strip).

ECG waveforms: Displayed at a fixed timebase of 25 mm/sec (printer) ±5%, 20 mm/sec (display) ±10%.

ECG Leads Off Sensing: 3- and 5-Lead wires apply a 30nA DC current.

Maximum T-Wave amplitude: Device rejects up to 80% of R-Wave amplitude for synchronized cardioversion; up to 55% of R-Wave amplitude for demand pacing; up to 34% of R-Wave amplitude for arrhythmia analysis.

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Frequency Response:

- ECG AC Line Filter - 50 Hz or 60 Hz.
- ECG for Display - 0.15-40 Hz, 0.05-40 Hz
- ECG for Printer - 0.05-150 Hz Diagnostic, 0.15-40 Hz, 0.05-40 Hz

Heart rate accuracy and response to irregular rhythm: Meets AAMI standard for ventricular bigeminy (HR=80 bpm); slow alternating ventricular bigeminy (HR=60 bpm); rapid alternating ventricular bigeminy (HR=120 bpm); bidirectional systoles (HR=90 bpm) as measured after a 20 sec stabilization time.

Heart rate averaging: For heart rates ≥ 50 bpm, heart rate is determined by averaging the 12 most recent R-R intervals. Beats N, P, and V are included. When heart rate drops below 50 bpm, the four most recent R-R intervals are used in the average. Note: For ventricular tachycardia alarms, which have a user-definable PVC run length limit, the heart rate is based on the user-selected PVC length up to 9 PVCs maximum.

Pace Pulse Detection Sensitivity: 1 mV for a width of 100 µs; 200 µV for a 500 µs width and 200 µV for widths of 500 µs to 2 ms.

ECG Analog Output Bandwidth: 0.5 to 70 Hz

ECG Analog Output Gain: 1v output per 1mV input ±10%

ECG Analog Output Delay: Propagation delay time is <35ms from ECG input to ECG analog output.

Pacemaker Pulse Rejection Capability: Amplitude from ± 2 mV to ± 700 mV, width from 0.1 ms to 2.0 ms as per ANSI/AAMI EC 13:2002 4.1.4.1.

Pacer Pulse Detector rejection of Fast ECG Signals: Slew Rate of 1.1 V/s.

Heart Rate Response Time: 7 sec (80-120 bpm); 6 sec (80 to 40 bpm).

Time to Alarm for Tachycardia: 4 sec for 206 bpm (1 mV, halved amplitude and double amplitude) and 195 bpm (2 mV, halved amplitude and double amplitude) as measured following a normal 80 bpm rate with upper alarm limit set at 100 and lower alarm limit set at 60 bpm.

Patient Isolation (Defibrillation Proof):

- Lead ECG: Type CF
- SpO_2: Type CF
- NBP: Type CF
- Pads/Paddles: Type BF
- Internal Paddles: Type CF

Other consideration: The HeartStart XL+ is suitable for use in the presence of electrosurgery. Burn hazard protection is provided via a 1K current-limiting resistor contained in each ECG lead wire. Proper lead placement (see “Electrode Placement” on page 45) is important to reduce burn hazards in the event of a defect in the electrosurgical equipment.

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Display

Size: Approximately 6.5 in (16.5 cm) diagonal viewing area.

Type: Color TFT LCD.

Resolution: 640 x 480 pixels (VGA) with 32 brightness levels per color.

Sweep Speed: 20 mm/s nominal (stationary trace; sweeping erase bar) for ECG and SpO_2.

Wave Viewing Time: 5.2 sec

Battery

Type: Rechargeable, Lithium Ion; See battery label for capacity information.

Dimensions: 23.6mm (H) x 116mm (W) x 146 mm (L); 1 in (H) x 4.5 in (W) x 5.7 in (L)

Weight: Approximately .68kg (1.5 lbs)

Charge Time with Device Turned Off and AC Power Connected: With the temperature between 0-35° C (32-95° F), less than 3 hours to 100% capacity; less than 2 hours to 80% capacity.

Charge Time with Device On and AC Power Connected: Charge time is less than 10 hours.

Capacity: With a new fully charged battery, at 20 °C (68 °F), one of the following:

At least 3 hours of monitoring (ECG and SpO_2 monitored continuously and NBP sampled every 15 minutes) followed by 20 full-energy charge/shocks.

At least two hours of pacing (180ppm at 140mA with 40 msec pulse width) while monitoring (ECG and SpO_2 monitored continuously and NBP sampled every 15 minutes) followed by 20 full-energy charge/shocks.

At least 175 full-energy charge/shocks.

Battery Indicators: Battery gauge on battery, capacity indicator on display, power indicators on front of device; flashing RFU indicator, chirp and **Low Battery** messages on the display for low battery condition. When a low battery message first appears there is still enough energy for at least 10 minutes of monitoring and 6 maximum energy discharges.

Battery Storage: Storing the battery for extended periods at temperatures above 40° C (104° F) reduces battery capacity and degrades battery life.

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Thermal Array Printer

Continuous ECG Strip: The Print key starts and stops the strip. The printer can be configured to be run real time or with a 10-second delay. The strip prints the primary ECG lead and a second wave with event annotations and measurements.

Auto Printing: The printer can be configured to automatically print on Mark Events, Charge, Shock and Alarm.

Reports: The following can be printed:

- Event Summary (Long or Short)
- Vital Signs Trends
- Operational Check
- Configuration
- Status Log
- Device Information

Speed: 25 mm/s with an accuracy of ±5%

Amplitude Accuracy: 5% for offset voltages of ± 300 mV at 5Hz

Paper Size: 50 mm (W) x 30 m (L)

Noninvasive Pacing

Waveform: Monophasic

Current Pulse Amplitude: 10 mA to 200 mA if the pulse width is set to 20 ms (5 mA increments); accuracy ±10% or ±5 mA whichever is greater. For a 40 ms setting, the maximum pacing current is 140 mA.

Pulse Duration: 20 or 40 msec with ±10% accuracy

Rate: 30 ppm to 180 ppm (10 ppm increments); accuracy ±1.5%

Mode: Demand or Fixed

Refractory Period: 340 msec (30 to 80ppm); 240 msec (90 to 180 ppm) ±10%

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SpO_2 Pulse Oximetry

SpO_2 Measurement Range: 0-100%

SpO_2 Resolution: 1%

SpO_2 Update Period: 1-2 sec typical; maximum of ≤ 30 sec

Table 53 **SpO_2 Accuracy** (with 1 standard deviation 70-100%)

Sensor	Accuracy	Sensor	Accuracy	Sensor	Accuracy
M1131A	±3%	M1191BL	±2%	M1196A	±3%
M1132A	±2%	M1191T	±3%	M1196S	±3%
M1133A	±2%	M1192A	±2%	M1196T	±3%
M1191A	±2%	M1192T	±3%	M1902B	±3%
M1191B	±2%	M1194A	±3%	M1903B	±3%
M1191AL	±2%	M1195A	±3%	M1904B	±3%

NOTES: Accuracy outside the range specified for each sensor is not indicated. The above referenced sensors were validated for use with the HeartStart XL+ using the Philips picoSAT II SpO_2 module with Fourier Artifact Suppression Technology (FAST).

While the SpO_2 module is able to report values below 70% and alarm limits can be set below 70%, the accuracy of measurements less than 70% has not been validated.

SpO_2 accuracy was validated in human studies against arterial blood sample references measured with a CO-oximeter. In a controlled desaturation study, healthy adult volunteers with saturation levels between 70-100% SaO_2 were studied. The population characteristics for those studies were approximately 50% male and 50% female, ranging in age from 19-39 with skin tone from light to dark.

Pulse oximetry equipment measurements are statistically distributed, therefore only two-thirds of pulse oximeter equipment measurements can be expected to fall within ±Arms of the value measured by a CO-oximeter.

Functional test equipment designed for SpO_2 testing cannot be used to assess the accuracy of the SpO_2 readings.

See the sensor's instructions for use for the maximum temperature possible at the sensor-skin interface and other information such as intended patient population, sensor application sites and use criteria.

The HeartStart XL+ is calibrated to display functional oxygen saturation.

Ambient Light Sensitivity: Interference from fluorescent light is <2% SpO2 under the following conditions: 0.3 and 1% perfusion, 50 nA/mA transmission, 10 to 1000 lx light intensity, 50/60Hz power line frequency ±0.5 Hz line frequency.

SpO_2 Alarm Range:

Low Limit: 50-99% (Adult and Infant/Child)

High Limit: 51-100% (Adult and Infant/Child)

SpO_2 and Pulse High/Low Alarm Signal Generation Delay: 10 seconds

SpO_2 Response Time (90 to 80 %): average 18.9 seconds, standard deviation 0.88 seconds

SpO_2 and Pulse Averaging Time: 10 sec

Emitted Light Energy: ≤15 mW

Wavelength Range: 500-1000 nm (Information about wavelength range can be useful to clinicians, especially those performing photodynamic therapy.)

Desat Alarm Signal Generation Delay: 20 sec

Pulse Rate Measurement Range: 30-300 bpm

Pulse Rate Resolution: 5 bpm

Pulse Rate Accuracy: 2% or 1 bpm whichever is greater

Pulse Response Time (90 to 120 bpm): average 18.0 seconds, standard deviation 0.86 seconds

Pulse Alarm Range:

Low Limit: 30-295 (Adult and Infant/Child)

High Limit: 35-300 (Adult and Infant/Child)

NBP

Pressure Range:

Measurement	mmHg		kPa	
	Adult	Infant/Child	Adult	Infant/Child
Systolic	40-260	40-160	5-35	5-21
Diastolic	20-200	20-120	2-27	2-16
Mean	26-220	26-133	3-30	3-18

Pulse Rate Range: 30 to 220 bpm

Initial Pressure: 160 mmHg, 21 kPa (adult); 120 mmHg, 16 kPa (Infant/Child)

Maximum Pressure: 300 mmHg; 40 kPa

Overpressure Safety Limits: 300 mmHg; 40 kPa

Cuff Inflation Time: 75 sec maximum

Pressure Transducer Accuracy: ±3 mmHg over the range 1-300 mmHg/.1-40 kPa

Alarm Range:

Measurement	mmHg		kPa	
	Adult	Infant/Child	Adult	Infant/Child
Systolic high limit	45-260, **160**	45-160, **120**	6-35, **21**	6-22, **16**
Systolic low limit	40-255, **90**	40-155, **70**	5-34, **12**	5-21, **9**
Diastolic high limit	25-200, **90**	25-120, **70**	3-27, **12**	3-16, **9**
Diastolic low limit	20-195, **50**	20-115, **40**	2-26, **7**	2-15, **5**
Mean high limit	30-220, **110**	30-135, **90**	4-30, **15**	4-18, **12**
Mean low limit	25-215, **60**	25-130, **50**	3-29, **8**	3-17, **7**

Auto Mode Repetition Time: 1, 2.5, 5, 10, 15, 30, 60 or 120 min

Maximum Measurement Time: 120 sec

Interconnect Tube Length:

M1598B Connect tubing 1.5 m (4.92 ft.)

M1599B Connect tubing 3.0 m (9.24 ft.)

Recommended Frequency of Pressure Transducer Calibration: Yearly

Patient Data Storage

Internal Event Summary: The HeartStart XL+ can store up to 8 hours of 2 continuous ECG waves, 1 pleth wave, research waves (AED Mode only) events and trending data per Event Summary. There is a maximum capacity of approximately 50 Event Summaries of approximately 30 minutes in length.

Environmental

Temperature: 0°C to 45°C (32°F to 113°F) operating; -20°C to 70°C (-4°F to 158°F) storage

- Charging the battery at temperatures above 45°C (113°F) may degrade battery life
- Storing the battery for extended periods at temperatures above 40°C (104°F) reduces battery capacity and degrades battery life.

Humidity: Up to 95% relative humidity

- Printer paper may jam if the paper is wet.
- Thermal printer may be damaged if wet paper is allowed to dry while in contact with printer elements.

Atmospheric Pressure Range: Operating and Storage - 1014 mbar to 572 mbar (0 to 15,000 ft; 0 to 4,500 m).

Shock:

Operating: Half-sine waveform, duration ≤11ms, acceleration ≥ 15.3 G, 3 shocks per face.

Non-operating: Trapezoidal waveform, acceleration 30G, velocity change 7.42 m/s ±10% 1 shock per face.

Vibration:

Operating Random			Non-Operating Swept Sine		Non-Operating Random		
Frequency (Hz)	**Slope (dB/octave)**	**PSD $(m/s^2)^2/Hz$**	**Frequency (Hz)**	**Amplitude**	**Frequency (Hz)**	**PSD**	**Acceleration**
10-100	—	1.0	10-57	± .15 mm	5-500	0.0117 g^2/Hz	~ 2.41 Grms
100-200	-3.0	—	57-150	2 g			
200-2000	—	0.5					

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Water/Solids Ingress Resistance: Meets Ingress Protection level IP21.

EMC: Complies with the requirements of standard EN 60601-1-2:2002.

Safety: Meets UL 60601-1 (1st edition), EN 60601-2-4:2003, EN 60601-1:1990.

Other considerations:

- The HeartStart XL+ is not suitable for use in the presence of concentrated oxygen or a flammable anesthetic mixture with air, oxygen or nitrous oxide.
- Hazards arising from software errors were minimized by the product's compliance with the software requirements contained in EN 60601-1-4:1996.

Mode of Operation: Continuous

AC Line Powered: 100-240 VAC, 50 or 60 Hz, 1 - 0.46 A, Class I Equipment

Battery Powered: Minimum 14.4 V, Rechargeable Lithium Ion

USB Device

Correct Drive: Use the USB Drive that accompanied your device. If it is not available, use a USB device that is USB 2.0 compatible and is ≤ 32 gigabytes.

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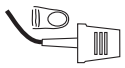
Symbol Definition

Table 54 lists the meaning of each symbol appearing on the HeartStart XL+ and the Lithium Ion battery.

Table 54 **HeartStart XL+ Symbol Definitions**

Symbol	Definition	Symbol	Definition
	Dangerous voltage		Input
	Meets IEC type CF leakage current requirements and is defibrillator protected. (Patient Applied part is isolated and defib-proof suitable for direct patient contact including the heart or major arteries.)		This product has passed relevant safety tests by the CSA, a nationally recognized test lab.
			Device complies with the requirements of the Medical Device Directive 93/42/EEC.
	SpO_2 port		AC Current
	Output		Data In
	Caution - See operating instructions in Instructions For Use.		Electrostatic sensitive device
	This device can run off a battery.		Manufacture date
	Dispose of in accordance to your country's requirements.		RoHS exempt. Environmentally friendly for a use period of 50 years.
	Consult Instructions For Use		DC Current
	UL Recognized Component for Canada and the United States		Rechargeable battery
	USB Port		Meets IEC type BF leakage current requirements and is defibrillator protected. (Patient Applied Part is isolated and defib-proof suitable for direct patient contact except the heart or major arteries.)

NOTE: For definitions of symbols which appear on the HeartStart XL+'s front panel see "Front of the Device" on page 6 and "General Function Buttons" on page 23. For definitions of symbols which appear on the external paddles see "External Paddles" on page 11. For RF transmission symbol definition see page 212.

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Shipper Carton Symbol Definitions

Table 55 lists the meaning of each symbol appearing on the HeartStart XL+ shipping carton.

Table 55 **Carton Symbol Definitions**

Symbol	Definition	Symbol	Definition
	Fragile		Temperature Range
	Do not get wet		Atmospheric pressure range
	Stack only three high		Relative humidity range
	Device complies with the requirements of the Medical Device Directive 93/42/EEC.		Recyclable paper product

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Abbreviation Definitions

Table 56 lists various abbreviations used with the HeartStart XL+ and in these Instructions for Use.

Table 56 **Abbreviations**

Abbreviation	Definition	Abbreviation	Definition
%	percent	µs	microseconds
°C	degrees Celsius	µV	microVolt
°F	degrees Fahrenheit	mA	milliAmpere
AC	alternating current	mV	milliVolt
bpm	beats per minute	min	minutes
cm	centimeter	mmHg	millimeters of mercury
dB	Decibel	ms	millisecond
dB(A)	A-weighted decibels	mW	milliwatt
Hz	hertz	nM	nanometer
in	inches	NSA	No Shock Advised
J	Joules	PSD	Power Spectral Density
kg	kilograms	RFU	Ready For Use
kPa	kilo Pascal	sec	seconds
Lbs	Pounds	V	Volt
m	meter		

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Electromagnetic Compatibility

When using the HeartStart XL+, electromagnetic compatibility with surrounding devices should be assessed.

A medical device can either generate or receive electromagnetic disturbances. Testing for electromagnetic compatibility EMC with the appropriate accessories has been performed according to the international standard for EMC for medical devices (IEC 60601-1-2). This IEC standard has been adopted in Europe as the European Norm (EN 60601-1-2).

The EMC standards describe tests for both emitted and received interference. Emission tests deal with electromagnetic disturbances generated by the device being tested.

WARNINGS: Radio frequency (RF) disturbances or emissions from devices other than the HeartStart XL+ might degrade performance of the HeartStart XL+. Electromagnetic compatibility with surrounding devices should be assessed prior to using the defibrillator.

Fixed, portable, and mobile radio frequency communications equipment could affect the performance of medical equipment. See Table 60 on page 213 for the minimum recommended separation distance between RF communications equipment and the HeartStart XL+.

Reducing Electromagnetic Interference

The HeartStart XL+ and associated accessories might be susceptible to interference from other RF energy sources and continuous, repetitive, power line bursts. Examples of other equipment that can cause RF interference are medical devices, cellular products, information technology equipment and radio/television transmission. Should interference be encountered, as demonstrated by artifact on the ECG or dramatic variations in parameter measurement values, attempt to locate the source. Assess:

- Is the interference intermittent or constant?
- Does the interference occur only in certain locations?
- Does the interference occur only when in close proximity to certain medical devices?
- Do parameter measurement values change dramatically when the AC line cord is unplugged?

Once the source is located, attempt to attenuate the EMC coupling path by distancing the monitor/defibrillator from the source as much as possible. If assistance is needed, call your local service representative.

Essential Performance Determinations

per 60601-1-2: Ed. 2

Essential performance of the HeartStart XL+ defibrillator/monitor derived from the product's risk Management Summary:

- The ability to deliver defibrillation therapy (manual, AED and Synchronized Cardioversion).
- The ability to deliver pacing therapy (fixed and demand).

This includes ancillary functions, such as ECG, which affect the ability to deliver defibrillation or pacing therapy.

All other functions are considered nonessential performance but were monitored for EMC.

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Restrictions for Use

Artifact on the ECG and parameter waveforms caused by electromagnetic disturbances should be evaluated by a physician or physician-authorized personnel to determine if it will negatively impact patient diagnosis or treatment.

Emissions and Immunity

The HeartStart XL+ is designed and tested to comply with the radiated and conducted emissions requirements of international and national standards IEC 60601-1-2 and EN 60601-1-2. See Tables 57 through 60 for detailed information regarding declaration and guidance.

WARNING: The use of accessories, transducers and cables other than those specified might result in increased emissions or decreased immunity of the HeartStart XL+.

The list of cables, transducers, and other accessories with which Philips claims compliance with the emissions and immunity requirements of IEC standard 60601-1-2 are listed in “Supplies & Accessories” on page 189.

The EMC standards state that manufacturers of patient-coupled equipment must specify immunity levels for their systems. See Tables 58 and 59 for this detailed immunity information. See Table 60 for recommended minimum separation distances between portable and mobile communications equipment and the HeartStart XL+.

Immunity is defined in the standard as the ability of a system to perform without degradation in the presence of an electromagnetic disturbance. Degradation in ECG quality is a qualitative assessment which could be subjective.

Caution should, therefore, be taken in comparing immunity levels of different devices. The criteria used for degradation is not specified by the standard and might vary with the manufacturer.

Guidance and Manufacturer’s Declaration

The HeartStart XL+ is intended for use in the electromagnetic environment specified in the tables below. The customer or the user of the HeartStart XL+ should assure that it is used in such an environment.

Table 57 **Electromagnetic Emissions**

Emissions Test	Compliance	Electromagnetic Environment - Guidance
RF emissions CISPR 11	Group 1	The HeartStart XL+ uses RF energy only for its internal function. Therefore, its RF emissions are very low and not likely to cause interference in nearby electronic equipment.
RF emissions CISPR 11	Class B	The HeartStart XL+ is suitable for use in all establishments, including domestic establishments or those directly connected to the public low-voltage power supply network that supplies buildings used for domestic purposes.
Harmonic emissions IEC 61000-3-2	Class A	
Voltage fluctuations/flicker emissions IEC 61000-3-3	Complies	

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Table 58 **Electromagnetic Immunity - General**

Immunity Test	IEC 60601 Test Level	Compliance Level	Electromagnetic Environment - Guidance
Electrostatic discharge (ESD) IEC 61000-4-2	± 6 kV contact ± 8 kV air	± 6 kV contact ± 8 kV air	Floors should be wood, concrete, or ceramic tile. If floors are covered with synthetic material, the relative humidity should be at least 30%.
Electrical fast transient/burst IEC 61000-4-4	± 2 kV for power supply lines ±1 kV for input/output lines	± 2 kV for power supply lines +1 kV for input/output lines	Mains power quality should be that of a typical commercial or hospital environment.
Surge IEC 61000-4-5	± 1 kV differential mode ± 2 kV common mode	±1 kV differential mode + 2 kV common mode	
Voltage dips, short interruptions, and voltage variations on power supply input lines IEC 61000-4-11	< 5% U_T (> 95% dip in U_T) for 0,5 cycle 40% U_T (60% dip in U_T) for 5 cycles 70% U_T (30% dip in U_T) for 25 cycles < 5% U_T (> 95% dip in U_T) for 5 sec	< 5% U_T (> 95% dip in U_T) for 0,5 cycle 40% U_T (60% dip in U_T) for 5 cycles 70% U_T (30% dip in U_T) for 25 cycles < 5% U_T (> 95% dip in U_T) for 5 sec	
Power frequency (50/60 Hz) magnetic field IEC 61000-4-8	3 A/m	3 A/m	Power frequency magnetic fields should be at levels characteristic of a typical location in a typical commercial or hospital environment.
U_T is the AC mains voltage prior to application of the test level.			

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Table 59 **Electromagnetic Immunity - Life-Supporting Systems**

Immunity Test	IEC 60601 Test Level	Compliance Level	Electromagnetic Environment - Guidance
			Portable and mobile RF communications equipment should be used no closer to any part of the HeartStart XL+ including cables, than the recommended separation distance calculated from the equation applicable to the frequency of the transmitter.
Conducted RF IEC 61000-4-6	3 Vrms 150 kHz to 80 MHz outside ISM bands[a]	3 Vrms	Recommended Separation Distance: $d = 1.2\sqrt{P}$
	10 Vrms 150 kHz to 80 MHz	10 Vrms	
Radiated RF IEC 61000-4-3	3 V/m* 10 V/m, 20 V/m** 80 MHz to 2.5 GHz	3 V/m 10 V/m, 20 V/m	$d = 1.2\sqrt{P}$ 80 MHz to 800 MHz $d = 2.3\sqrt{P}$ 800 MHz to 2.5 GHz where *P* is the maximum output power rating of the transmitter in watts (W) according to the transmitter's specified output power and *d* is the recommended separation distance in meters (m).[b] Field strengths from fixed RF transmitters, as determined by an electromagnetic site survey,[c] should be less than the compliance level in each frequency range.[d] Interference might occur in the vicinity of equipment marked with the following symbol:

* Applies to functions that are not considered life-supporting.

** No inadvertent energy delivery (per IEC 60601-2-4)

At 80 MHz and 800 MHz, the higher frequency range applies. These guidelines might not apply in all situations. Electromagnetic propagation is affected by absorption and reflection from structures, objects and people.

[a] The ISM (industrial, scientific, and medical) bands between 150 kHz and 80 MHz are 6.765 MHz to 6.795 MHz; 13.553 MHz to 13.567 MHz and 26.957 MHz to 27.283 MHz; and 40.66 MHz to 40.70 MHz. [b] The compliance levels in the ISM frequency bands between 150 kHz and 80 MHz and in the frequency range 80 MHz to 2.5 GHz are intended to decrease the likelihood that mobile/portable communications equipment could cause interference if it is inadvertently brought into patient areas. For this reason, an additional factor of 10/3 is used in calculating the recommended separation distance for transmitters in these frequency ranges. [c] Field strengths from fixed transmitters, such as base stations for radio (cellular/cordless) telephones and land mobile radios, amateur radio, AM and FM radio broadcast and TV broadcast cannot be predicted theoretically with accuracy. To assess the electromagnetic environment due to fixed RF transmitters, an electromagnetic site survey should be considered. If the measured field strength in the location in which the HeartStart XL+ is used exceeds the applicable RF compliance level above, the HeartStart XL+ should be observed to verify normal operation. If abnormal performance is observed, additional measures may be necessary, such as re-orienting or relocating the HeartStart XL+. [d] Over the frequency range 150 kHz to 80 MHz, field strengths should be less than 3 V/m.

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Recommended Separation Distances

The HeartStart XL+ is intended for use in an electromagnetic environment in which radiated RF disturbances are controlled. The customer or the user of the HeartStart XL+ can help prevent electromagnetic interference by maintaining a minimum distance between portable and mobile RF communications equipment (transmitters) and the HeartStart XL+ as recommended below, according to the maximum output power of the communications equipment.

Table 60 **Recommended Separation Distances**

	Separation Distances According to Frequency of Transmitter (m)	
Rated Maximum Output Power of Transmitter (W)	150 kHZ to 800 MHz $d = 1.2\sqrt{P}$	800 MHz to 2.5 GHz $d = 2.3\sqrt{P}$
0.01	0.1 m	0.2 m
0.1	0.4 m	0.7 m
1	1.2 m	2.3 m
10	4 m	7 m
100	12 m	23 m

For transmitters rated at a maximum output power not listed above, the recommended separation distance *d* in meters (m) can be determined using the equation applicable to the frequency of the transmitter, where *P* is the maximum output power rating of the transmitter in watts (W) according to the transmitter's manufacturer.

At 80 MHz and 800 MHz, the higher frequency range applies.

These guidelines might not apply in all situations. Electromagnetic propagation is affected by absorption and reflection from structures, objects and people.

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